West Sacramento GRR EIS/EIR
Appendix J

Final Biological Opinions

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Final Biological Opinions
Enclosure 1

USFWS Biological Opinion

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Suite W-2605
Sacramento, California 95825-1846

In Reply Refer to:
08ESMF00-
2014-F-0434-R001

DEC 0 2 2015

Ms. Alicia E. Kirchner
Chief, Planning Division
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814

Subject: Reinitiation of the West Sacramento Project General Reevaluation Report, Yolo County, California

Dear Ms. Kirchner:

This letter is in response to the U.S. Army Corps of Engineers (Corps) November 19, 2015, request for reinitiation of formal consultation with the U.S. Fish and Wildlife Service (Service) on the West Sacramento Project General Reevaluation Report (West Sacramento GRR Project or project) in Yolo County, California. Your request was received by mail from the Corps by the Service on November 23, 2015. The Corps has provided a clarification on the conservation measures for the federally-listed threatened giant garter snake (*Thamnophis gigas*). The revised conservation measures will cause a change in the effects analysis. To aid the reading of the revised biological opinion the Service is revising text within the document. Changed text will be bolded. This response is provided under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act), and in accordance with the implementing regulations pertaining to interagency cooperation (50 CFR 402).

The purpose of the West Sacramento GRR Project is to evaluate flood risk and provide improvements to flood management for the City of West Sacramento. It includes the Southport Project, which is to be completed as an early implementation project by the West Sacramento Area Flood Control Agency (WSAFCA) upon permission from the Corps, pursuant to Section 14 of the River and Harbors Act of 1899 (33 U.S.C. 408). Pursuant to 50 CFR 402.12(j), you submitted the biological assessment for our review and requested concurrence with the findings presented therein. These findings conclude that the proposed project may affect, and is likely to adversely affect the federally-threatened giant garter snake (*Thamnophis gigas*) (snake), federally-threatened valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (beetle), and federally-threatened delta smelt (*Hypomesus transpacificus*) (smelt), as well as delta smelt critical habitat.

In considering your request, we based our evaluation of the biological assessment's findings on the following: (1) your consultation request and biological assessment received November 24, 2014; (2) site visits with Service, Corps, WSFACA, ICF International (ICF) representatives, and others; (3) numerous meetings with the Service, Corps, National Marine Fisheries Service (NMFS), WSAFCA, ICF, and others; (4) e-mail correspondence and other communication between the Service and the Corps; and (5) other information available to the Service. A complete administrative record is on file at the Sacramento Fish and Wildlife Office.

Consultation History

May 26, 2011	The Service attended a stakeholders meeting outlining preliminary plans for the Southport Early Implementation Project (Southport Project). The Southport Project was planned to proceed in advance of the other portions of the West Sacramento GRR Project.
August 15, 2011	WSAFCA held a stakeholder meeting and field visit for the Southport Early Implementation Project of the West Sacramento GRR Project, which the Service and the Corps attended.
February 12, 2013	The Corps provided the Service a draft biological assessment prepared by ICF for the Southport Project.
February 21, 2013	The Service provided comments on the draft biological assessment for the Southport Project. The comments centered on the need to include the delta smelt in the biological assessment.
June 3, 2013	The Service attended a meeting and site visit along with representatives from WSAFCA, ICF, NMFS, the California Department of Fish and Wildlife (CDFW), and others to review the proposed plans for the Southport Project.
June 5, 2013	The Service received a formal consultation request for the Southport Project from the Corps, dated June 4, 2013, along with a biological assessment.
August 27, 2013	The Corps hosted a meeting with the Service, NMFS, WSAFCA, and ICF. Mike Hendrick (NMFS) noted that NMFS would be preparing an insufficiency letter based on the project design noted in the Southport Project biological assessment.
September 4, 2013	Harry Kahler (Service) e-mailed Tanis Toland (Corps) noting that in lieu of impending changes to the Southport Project description, work on the consultation would be suspended until the project description was updated.
December 18, 2013	The Service attended a meeting at ICF discussing design modifications to the Southport Project that addressed concerns raised in NMFS insufficiency letter and previous meetings.
January 23, 2014	The Service received from the Corps a draft biological assessment for the West Sacramento GRR Project. The biological assessment did not contain information regarding the Southport Project.
March 20, 2014	The Corps hosted a meeting attended by the Service and NMFS to discuss the inter-relatedness of concurrent projects – the Southport Project, the West Sacramento West Sacramento GRR Project, the Sacramento River Bank Protection Project, and the American River Watershed Investigation, Common Features, General Reevaluation Report Project.
April 21, 2014	The Corps hosted a meeting attended by the Service and NMFS. The Service recommended that the Southport Project and the West Sacramento GRR Project be included in one biological opinion.

June 9, 2014	The Service received a request from the Corps to initiate formal consultation on the West Sacramento GRR Project. The initiation letter and biological assessment included the Southport Project.
June 19, 2014	The Service conveyed to the Corps via telephone and e-mail that effects to smelt and smelt critical habitat are quantified in terms of acreage, rather than in linear feet of river, as is the case for salmonids. The Service requested the Corps provide the acreage of smelt shallow water habitat that is to be affected by the West Sacramento GRR Project.
July 23, 2014	The Service sent a letter to the Corps detailing the need for more information regarding the amount of smelt habitat that will be impacted by the project and the amount of smelt habitat that will be created.
September 24, 2014	The Service received a response from the Corps, dated September 23, 2014, describing the amount of smelt shallow water habitat that will impacted by the West Sacramento GRR Project and the amount that will be created by the Southport Project.
October 16, 2014	The Corps held a meeting with the Service and NMFS, stating that they would be seeking incidental take coverage from Section 9 of the Act for the West Sacramento GRR Project as a whole, rather than taking a programmatic approach.
October 20, 2014	The Service downloaded an updated biological assessment from the Corps' FTP site.
October 27, 2014	The Corps sent via electronic mail a copy of a letter to the Service that officially withdrew the June 4, 2013, request for consultation for the Southport Project based on updated information regarding the West Sacramento GRR Project Plans.
November 21, 2014	The Corps sent via electronic mail a new request to initiate formal consultation for the West Sacramento GRR Project. An electronic link was included that provided access to the November 2014 final biological assessment.
November 24, 2014	The Service received by mail the signed request to initiate formal consultation for the West Sacramento GRR Project along with the biological assessment that addressed concerns raised by the Service and NMFS following the initiation request received June 9, 2014.
November 25, 2014	The Service requested and received, via electronic mail and telephone conversations, clarification regarding the identification and selection of potential sites for construction borrow material. The Corps explained that although potential borrow sites are identified for the West Sacramento GRR Project, the sites are subject to field verification for suitability.
November 19, 2015	**The Corps sent a letter requesting reinitiation with the Service on the West Sacramento GRR Project.**

December 1, 2015 **The Corps sent an electronic mail to the Service with a request to revise the Conservation Measures for valley elderberry longhorn beetle.**

BIOLOGICAL OPINION

Description of the Action

In 2006, a comprehensive evaluation of West Sacramento levees was completed by WSAFCA, in conjunction with the California Department of Water Resources, to determine the current level of flood protection provided by the levee system, to identify the magnitude and severity of levee deficiencies, and to propose flood risk reduction measures (HDR 2008). Results of the comprehensive evaluation revealed multiple levee deficiencies that would require substantial improvements to meet flood protection standards as implemented federally by the Corps. Furthermore, Senate Bill 5 signed in 2007 by Governor Arnold Schwarzenegger requires that urban areas such as West Sacramento achieve 200-year level flood protection by 2025.

The West Sacramento GRR Project is a Corps feasibility study of the improvements needed to provide West Sacramento with 200-year level flood protection. Its primary purpose is to assess and address the levee deficiencies on the nearly 50 miles of levees surrounding West Sacramento. Improvements to levees will be made incrementally, rather than altogether as one large project. In fact, three levee reaches with severe deficiencies have already been constructed by WSAFCA as Early Implementation Projects at the I Street Bridge, the CHP Academy, and The Rivers sites, all progressing in advance of the West Sacramento GRR Project. A fourth Early Implementation Project, known as the Southport Project, is included herein as part of the West Sacramento GRR Project.

West Sacramento is divided into two basins by levees, a north basin of about 6,100 acres and a south basin of about 6,900 acres. Deficiencies identified among different levee reaches of each basin generally include seepage, slope stability, erosion, and height insufficiencies (Figure 1). Construction will occur sequentially through each levee reach over a 19-year period, beginning with the Sacramento River South Levee. As a proposed Early Implementation Project, the Southport Project design along the Sacramento River South levee reach is more refined and detailed than the rest of the West Sacramento GRR Project. The proposed levee remediation measures vary among the nine levee reaches of the two basins and are summarized in Table 1.

Figure 1. West Sacramento General Reevaluation Report Project levee deficiencies, City of West Sacramento, Yolo County, California (Corps 2014b).

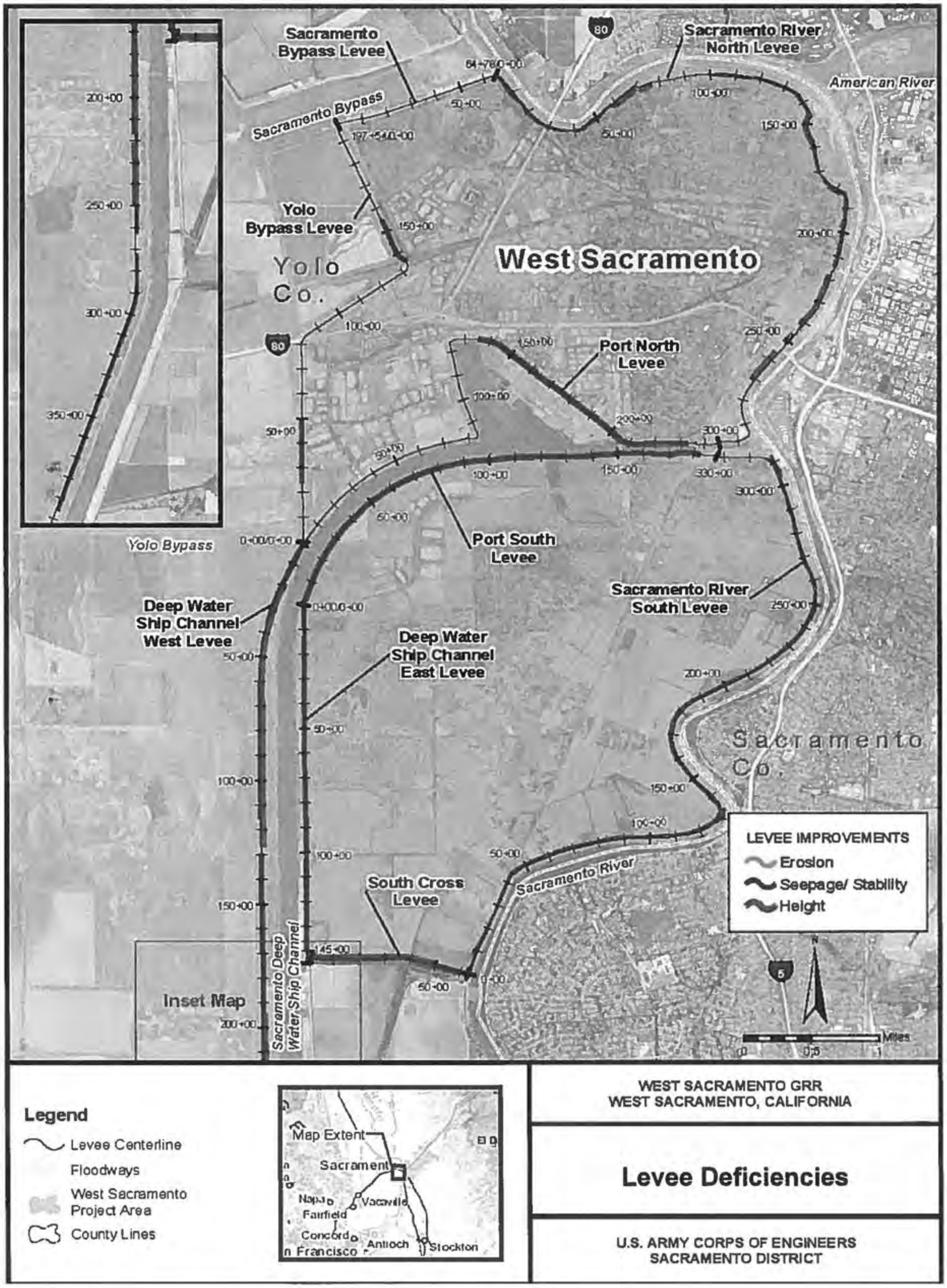


Table 1. Proposed remediation by levee reach, West Sacramento General Reevaluation Report, City of West Sacramento, Yolo County, California (Corps 2014b).

Levee Reach	Construction Sequence and Duration*	Seepage Remediation	Stability Remediation	Overtopping Remediation	Erosion Protection
	NORTH BASIN				
Sacramento River North	3 (2 years)	Cutoff Wall	Cutoff Wall	Levee Raise	Bank Protection
Port North	9 (2 years)	---	---	Floodwall	---
Yolo Bypass	4 (1 year)	Cutoff Wall	Cutoff Wall	---	---
Sacramento Bypass Training Levee	2 (1 year)	---	---	---	Bank Protection
	SOUTH BASIN				
South Cross	8 (2 years)	Stability Berm, Relief Wells	---	Levee Raise	---
Deep Water Ship Channel East	7 (3 years)	Cutoff Wall	Cutoff Wall	Levee Raise	Bank Protection
Deep Water Ship Channel West	5 (3 years)	Cutoff Wall	Cutoff Wall	Levee Raise	---
Port South	6 (1 year)	Cutoff Wall	Cutoff Wall	Levee Raise	---
Sacramento River South	1 (3 years)**	Setback Levee, Cutoff Wall, Seepage Berm	Setback Levee, Cutoff Wall, Seepage Berm	---	Setback Levee, Bank Protection

* Construction throughout all levee reaches is scheduled to occur sequentially over a 19-year period.

** Construction of flood-risk reduction measures will require 3 years; contouring and restoration of the associated offset floodplain area will require an additional 3 years.

Operation and Maintenance

As construction along levee reaches throughout the West Sacramento GRR Project area is completed, re-sloping and compacting will occur as needed. After construction, piezometers will be installed at various locations along the levees to monitor groundwater levels. Monthly visual inspections by driving along access roads on the crown will monitor levee conditions. Access roads will be maintained yearly with new aggregate base or substrate if necessary. Upon completion of construction, levees will be maintained per the approved operations and maintenance (O&M) manual applicable to each levee reach throughout the West Sacramento GRR Project area. Levees are expected to be mowed up to four times a year to control vegetation. Herbicide applications will be used as needed. Burrowing mammal activity will be controlled monthly by baiting with pesticides.

Details of each specific construction measures are described below, followed by descriptions of the deficiencies and corrective construction measures for each levee reach of the West Sacramento GRR Project.

Construction Methods

Several construction methods will be used to alleviate seepage, slope stabilization concerns, overtopping, and erosion. In addition, some general construction measures will be implemented throughout the West Sacramento GRR Project, regardless of the specific corrective measures that will be applied. Flood risk reduction measure construction activities will primarily occur during the typical construction season for flood control projects, April 15 to October 31.

General Construction Measures

Standard Levee Footprint

On all levees that are out of compliance with Corps policies, a standard levee footprint will be established during construction. The standard levee footprint consists of a 20-foot crown with 3 horizontal:1 vertical (3H:1V) levee slopes. If a 3H:1V landside slope is not possible given the site-specific conditions, then a minimum slope of 2H:1V will be established. Also, a 20-foot-wide maintenance access buffer will be established on both the landside and waterside levee toes. If 20 feet is not possible, given site-specific conditions, then a minimum of 10 feet will be designed as a buffer. All encroachments into the levee footprint will be brought into compliance with Corps policy or removed. Encroachments include buildings, certain vegetation, utility poles, and pump stations, as well as underground pipes, conduits, and cables. Bringing into compliance generally means relocation, reconstruction, or retrofitting. Any utility lines found within the levee footprint will either be relocated above the new levee prism, or equipped with positive closure devices for through-lines. Private encroachments will be removed by the non-Federal sponsor (WSAFCA) or property owner prior to construction.

Vegetation Policy Compliance

The Corps has established and plans to follow guidelines for landscape planting and vegetation management at levees, floodwalls, embankment dams, and appurtenant structures, as described in Engineering Technical Letter (ETL) 1110-2-583 (Corps 2014a). The primary purpose of the vegetation-free zone is to provide a reliable corridor of access to, and along, flood control structures. A three-dimensional vegetation-free zone will surround all levees, floodwalls, embankment dams, and critical appurtenant structures in all flood damage reduction systems. The vegetation-free zone applies to all vegetation except perennial grass species, which are permitted for the purpose of erosion control. The vegetation free zone extends 15 feet from both landside and waterside levee toes, and 8 feet vertically.

A variance from the vegetation policy is being sought for work along the Sacramento River North and Sacramento River South levee reaches. Along much of the Sacramento River within the project area, the distance between the levee toe and the river waterline is sufficient to allow vegetation to remain along the riverbank without a variance. However; in some places, trees will be thinned along the Sacramento River North Reach to allow placement of rock slope protection, and therefore would require a variance.

Borrow Materials

A maximum estimate of 9 million cubic yards of borrow material will be needed to construct the West Sacramento GRR Project. Because most of the project is in the preliminary stages of design, detailed studies of each levee reach borrow needs have not been completed. A worst case scenario was evaluated for the volume of borrow material needed. Actual volumes exported from any single borrow site may be adjusted to match demands for fill.

To identify potential locations for borrow material, soil maps and land use maps were obtained for a 20-mile radius surrounding the West Sacramento GRR Project area (Figure 2). The criteria used to determine potential locations were based on current land use patterns, soil types from U.S. Soil Conservation Service (SCS), and the Corps' criteria for material specifications. The data from the land use maps and the SCS will be field verified. To reduce impacts, the closest identified potential borrow sites will be evaluated for suitability first, with additional sites being evaluated as needed. Any identified potential borrow sites outside of the City of West Sacramento that may affect federally-listed species, or may adversely modify designated federally-listed species critical habitat, will not be used for borrow material. Borrow sites will only be obtained from willing sellers.

The excavation limits on the borrow sites will provide a minimum buffer of 50 feet from the edge of the site boundary. From this setback, the slope from the existing grade down to the bottom of the excavation will be no steeper than 3H:1V. Excavation depths from the borrow sites will be determined based on available suitable material and local groundwater conditions. The borrow sites will be stripped of top material and excavated to appropriate depths. Once material is extracted, borrow sites will be returned to their existing use whenever possible, or these lands could be used to mitigate for project effects, if appropriate.

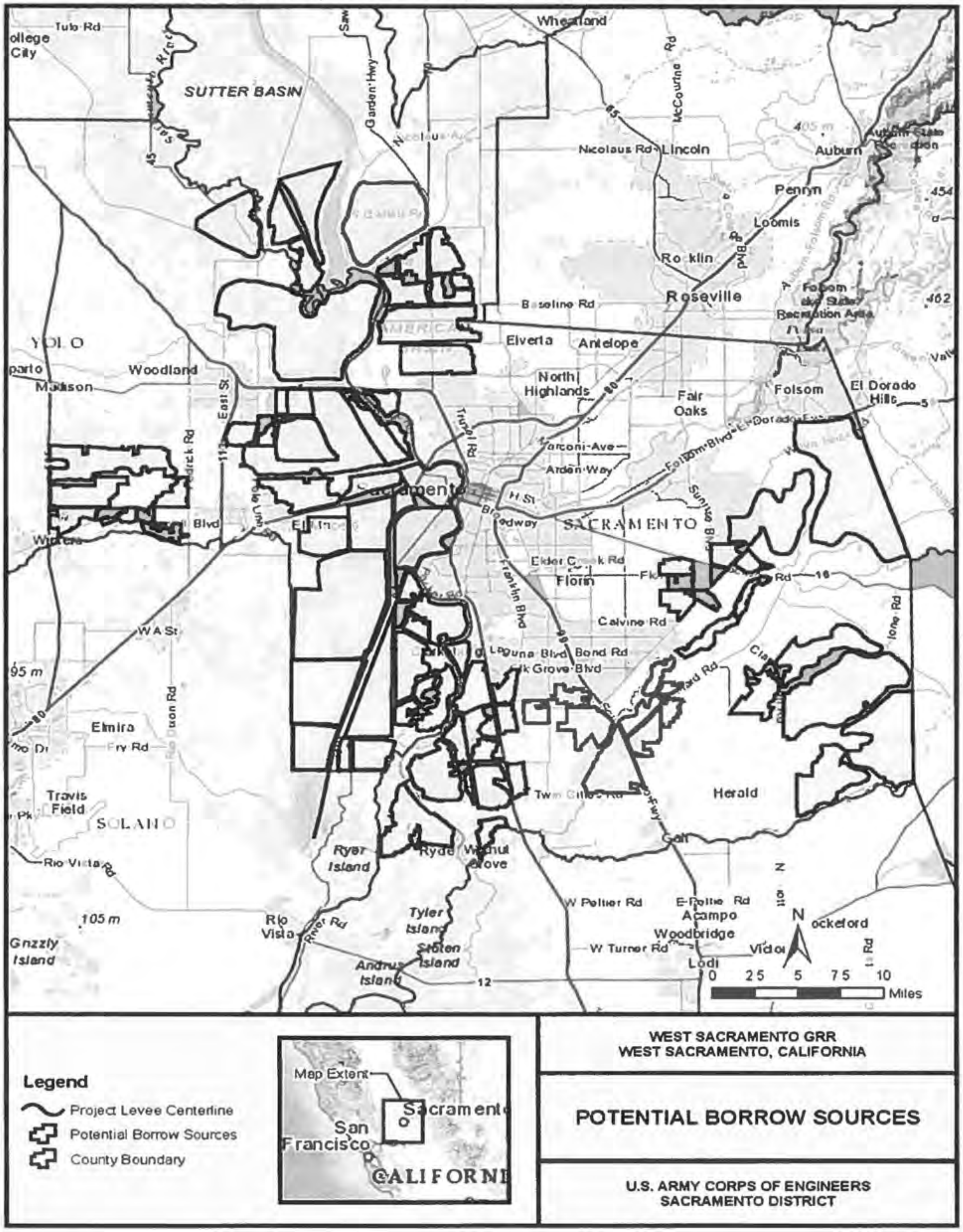
<u>Seepage Remediation and Slope Stabilization</u>

Slurry Cutoff Walls

<u>Conventional Open Trench Cutoff Wall</u>: A 3-foot-wide trench is dug from the top of the levee centerline up to 85 feet deep into the substrate materials. As the trench is excavated, it is filled with a temporary bentonite slurry to prevent cave-ins. To form the wall, the soil from the excavation is mixed with hydrated bentonite or cement and backfilled into the trench, displacing the temporary slurry. Once the permanent soil-slurry mix is hardened, the levee embankment is reconstructed and capped with an impervious or semi-impervious soil. Heavy equipment to be used for cutoff walls includes bulldozers, haulers, excavators, scrapers, rollers, and water trucks.

<u>Clamshell Method Cutoff Wall</u>: The clamshell method is similar to the conventional open trench method, yet also employs a dragline crane with a clamshell bucket. The initial trench is excavated and backfilled as described for the conventional open trench method, yet the dragline crane and clamshell bucket is used when the trench becomes too deep to complete conventionally. The bentonite grout is mixed with the native soil and poured in the trench as the clamshell is removed. Cement is added to the mix at times to add strength and decrease curing time.

Figure 2. Potential Locations for Borrow Material within a 20-mile Radius of the West Sacramento General Reevaluation Report Project action area, California, 2014.



Deep Soil Mixing Cutoff Wall: At the wall site a crane with two to four augers will drill through the levee crown to a depth of up to 140 feet. High-pressure hoses will carry the grout from the batching plant to the wall site, where the grout is injected through the augers and mixed with native soils. As the drilling apparatus progresses along the levee crown, a series of overlapping columns of grout mixture are left to form the wall.

Because large quantities of a cement-bentonite grout are used, a contractor-provided onsite batch plant is necessary. The batch plant will consist of an aggregate storage system, an aggregate rescreen system if needed, a rewashing facility if needed, the batching system, cement storage, ice manufacturing, and the grout mixing and loading system. All aggregate used within the batch plant operations will be obtained from local commercial sources and delivered to the site. When the wall has hardened it is capped and the levee embankment is reconstructed with impervious or semi-impervious materials.

Jet Grouting: Jet grouting typically is used in constructing a slurry cutoff wall to access areas other methods cannot. Jet grouting will be used around existing utilities not proposed for removal, and at bridges along the project levees. It involves injecting fluids or binders into the soil at very high pressure to a maximum depth of about 130 feet. The injected fluid can be grout; grout and air; or grout, air, and water. Jet grouting breaks up soil and, with the aid of a binder, forms a homogenous mass that solidifies over time to create a mass of low permeability.

Equipment required for jet grouting consists of a drill rig complete with a high flow pump and portable batch plant. Jet-grouted columns range from 1 to 16 feet in diameter and typically are interconnected to form cutoff barriers or structural sections. A construction crew usually consists of a site supervisor, pump operator, batch plant operator, chuck tender, and driller, and can construct two 6-foot diameter 50-foot columns per day consisting of about 100 cubic yards of grout injected per 8-hour shift.

To provide a wide enough working platform on the levee crown, the upper portion of some segments of the levee may require degradation with a paddle wheel scrapper. Material will be scraped and stockpiled at a nearby stockpile area. Hauling at the work area will involve scraper runs along the levee to the staging area, and grout, bentonite, and water deliveries to the batch plant.

Landside Berms

Seepage Berm: Seepage berms are constructed in areas where geotechnical investigations indicate that safely releasing seepage water on the landside is more appropriate than a cutoff wall. Generally a seepage berm extends outward from the landside toe of the levee to a width of 70 to 100 feet. The berm is about 5 feet high at the levee toe and tapers to about 3 feet high at the berm toe. The length of the berm is dependent upon the levee seepage concerns.

To construct a seepage berm, the ground is first cleared, grubbed and stripped. If the soil is found to be adequate for berm construction during levee degradation, it will be stockpiled for use later. Otherwise, soils from nearby borrow pits will be used, or if necessary, trucked onsite from other locations. A bulldozer and front-end loader will be used at borrow sites to load haul trucks. Motor graders will be used onsite to grade materials dumped by haul trucks. The fill material is placed in 1- to 2-foot lifts for compaction by sheepsfoot rollers. The width of the berm is dependent on the permeability of the fill material. Water trucks are used to aid compaction and decrease dust emissions. Upon completion, berms are hydroseeded with a native seed mix of grass and forbs. Additionally, some seepage berms are constructed with a drainage relief trench at the toe of the berm. Generally, a drainage trench is made with loose gravel or sand beneath the toe of the berm materials to allow the drainage of permeated water. Also, a 15-foot vegetation free zone running parallel to the seepage berm is designed to allow O&M access.

Stability Berm: Stability berms are constructed along the landside toe of levees with the purpose of providing support to the levee as a buttress. The height of a stability berm is usually 2/3 the height of the levee, and the length is dependent on the structural needs of the levee reach. The construction of stability berms is similar to the construction of seepage berms. Plans for the South Cross levee reach include a stability berm.

Adjacent Levees

Adjacent levee designs essentially widen the existing levee, thereby allowing the adjacent levee geometry to be restructured on the landside to a 3H:1V slope, and also adding stability. Because adjacent levees are constructed on the landside, the waterside levee slopes are generally left with existing vegetation in place.

The first construction phase includes clearing, grubbing, and stripping the work site and any construction staging areas, if necessary. A trapezoidal trench is cut at the toe of the slope and the levee embankment then is cut in a stair-step fashion to allow the new material to be keyed into the existing material. As with berm construction, bulldozers excavate and stockpile material from a nearby borrow site. Front-end loaders load haul trucks with the borrow material, and the haul trucks subsequently transport it to the adjacent levee site. After the haul trucks dump the material, dozers level it as needed. Sheepsfoot rollers compact the material, and water trucks distribute water over the material to ensure proper moisture for compaction. The landside levee will be graded at a 3H:1V slope, and the levee crown will be at least 20 feet wide. The slope may be track-walked with a dozer. The levee crown will be finished with an aggregate base or paved road, depending on the type and level of access desired. Either condition will require importation of material with dump trucks, placement with a loader and motor grader, and compaction. A paver will be required for asphalt placement.

Sheet Pile Wall

A sheet pile wall is proposed at the Stone Locks to tie together the levees on both sides of the Barge Canal at the end of the Sacramento River Deep Water Ship Channel. A trench will be excavated along the sheet pile alignment to allow the pile to be driven to the proposed depth. A driving template fabricated from structural steel will control the alignment as the sheet pile is installed. A hydraulic or pneumatically operated pile driving head attached to a crane drives the sheet pile into the levee crown to the desired depth (up to 135 feet). An additional crane or excavator may be used to facilitate staging of the materials. The conditions of the site, driving pressure, hydrostatic loads, and corrosion considerations will determine the thickness and configuration of the sheet piles.

Relief Wells

Relief wells are used to address underseepage and will be applied only on site-specific conditions rather than as a segment-wide application. They will be located along adjacent and setback levee toes in the South Basin and only in segments where geotechnical analyses have identified continuous sand and gravel layers and the presence of an adequate impermeable layer. Relief wells are passive systems that are constructed near the levee landside toe to provide a low-resistance pathway for under-seepage to exit to the ground surface in a controlled and observable manner. Relief wells generally are spaced at 50- to 150-foot intervals, dependent on the amount of underseepage, and extend to depths of up to 150 feet. Areas for relief well construction are cleared, grubbed, and stripped. During relief well construction, a typical well-drilling rig will be used to drill to the required depth and construct the well beneath the ground surface. The drill rig likely will be an all-terrain, track-mounted rig that could access the well locations from the levee toe.

Areas along the levee toe may be used to store equipment and supplies during construction of each well. Construction of each well and the lateral drainage system typically takes 10 to 20 days. Additional time may be required for site restoration.

Overtopping Remediation

Levee Height Raise

Height deficiencies are constructed as needed following the completion of cutoff wall installation and levee geometry corrections. The required additional materials will come from identified borrow pits, stockpiled in staging areas, and hauled to the site with trucks and front end loaders. The levee will be hydroseeded once construction is complete.

Floodwalls

Floodwalls are proposed along the Port North levee around the Port of West Sacramento. To begin the floodwall construction, the area will be cleared, grubbed, stripped, and excavation will occur to provide space to construct the footing for the floodwall. The floodwall largely will be constructed from pre-fabricated materials, although it may be cast or constructed in place, and will be constructed almost completely upright. The height of the floodwalls varies from 1 to 4 feet, as required by water surface elevations. The waterside slope will be re-established to its existing slope and the levee crown will grade away from the wall and be surfaced with an aggregate base.

Erosion Protection

Levee Slope Revetment

The primary erosion protection measure consists of waterside armoring of the levees to prevent erosion and subsequent damage to the levee. This measure consists of placing rock revetment on the river bank, and in some locations on the levee slope, to prevent erosion. The extent of the revetment will be based on site-specific analysis. Along the Sacramento Bypass Training levee, revetment will be placed on both sides of the levee to protect the levee in place when the Sacramento and Yolo Bypasses contain water. When necessary, eroded portions of the bank will be filled and compacted prior to the rock placement. The sites will be prepared by clearing and stripping the site prior to construction. Rock revetment will be placed around existing trees on the lower portion of the slope. Trees on the upper portion of the slope will be removed during degrading of levees for slurry cutoff walls and bank protection will be placed following reconstruction of the levee. Temporary access ramps will be constructed, if needed, using imported borrow material that will be trucked on site.

Revetment will be imported from an offsite location via haul trucks or barges. Revetment transported by haul trucks will be temporarily stored at a staging area located in the immediate vicinity of the construction site. A loader will be used to move revetment from the staging area to an excavator that will place the material on site. Rock required on the upper portions of the slopes will be placed by an excavator located on top of the levee. Rock placement from atop the levee will require one excavator and one loader for each placement site.

Revetment transported by barges will not be staged, but placed directly on site by an excavator. Rock required within the channel, both below and slightly above the water line at the time of placement, will be placed by an excavator located on a barge. The excavator will construct a large rock berm in the water up to an elevation slightly above the mean summer water surface. Construction will require two barges: one barge will carry the excavator, while the other barge will hold the stockpile of rock to be placed on the channel slopes.

The bank protection will be placed on the existing bank at a slope varying from 2V:1H to 3V:1H depending on site specific conditions. After rock placement is complete, a small planting berm will be constructed in the rock, when feasible, to allow for some revegetation of the site outside of the vegetation free zone required by ETL 1110-2-583.

Levee Biotechnical Measures

Biotechnical measures will be implemented along lower velocity reaches to preserve existing vegetation. Biotechnical measures include the use of plant material and minimal amounts of rock to stabilize the eroded slope and prevent further loss of levee materials.

Setback Levee

A setback levee is an entirely new section of levee built at some distance inland from the existing levee section to be replaced. The new levee section is constructed to meet current design standards for height and geometry. Similar to the levee slope stabilization methods, a setback levee construction site is first cleared, grubbed, stripped, and all encroachments into the alignment are removed. Materials are stockpiled at staging areas after being removed and hauled from borrow sites. Heavy equipment is used to manipulate materials on site. Once the designed height is reached, a slurry cutoff wall is put in the levee crown via the conventional slot trench method or clamshell method, depending on the necessary depth. Topsoil is added and the new levee section is hydroseeded. An all-weather, aggregate base is constructed on the levee crown.

North Basin Levee Reaches

Table 2 shows the extent to which each construction measure will occur within each levee reach in the North Basin. Refer to Figure 1 for the approximate location of each proposed improvement.

Sacramento River North

The Sacramento North levee reach extends 5.5 miles from the Sacramento Bypass southward to the William Stone lock structure at the north end of the Sacramento River Deep Water Ship Channel. It is scheduled as the third reach for construction of the project. Slurry cutoff walls will be installed to different depths along the reach to address seepage and slope stability concerns. The conventional open trench method will be used to install walls up to 85 feet deep. A deep slurry method will be used for walls that are installed to a depth greater than 85 feet. Also, to alleviate height deficiencies in some areas, the levee geometry will be restructured with fill materials. Erosion concerns along nearly the entire length of the Sacramento North levee reach will be addressed by bank protection measures. In general, bank protection will involve the placement of rock on the existing bank at a slope between 2V:1H to 3V:1H, depending on specific site conditions.

Table 2. The construction length, improvement, and construction measure of each levee reach within the North Basin of the West Sacramento General Reevaluation Report, City of West Sacramento, Yolo County, California (Corps 2014b).

North Basin Levee Reach	Length of Levee Reach (feet)	Length of Measure (feet)	Improvement	Measure
Sacramento River North Levee and Stone Lock Closure	31,270	30,000	Erosion	Bank Protection
		11,000	Seepage	Slurry Cutoff Wall to 30 feet
		1,500		Slurry Cutoff Wall to 80 feet
		500		Slurry Cutoff Wall to 45 feet
		5,500		Slurry Cutoff Wall to 110 feet
		4,600	Height	Embankment Fill
		550	Stone Lock Closure	Embankment Fill, Sheet Pile Wall
Port North Levee	23,225	8,500	Height	Floodwall, 4-10 feet
		14,000	Height	Embankment Fill
Yolo Bypass Levee	19,749	2,500	Seepage	Slurry Cutoff Wall to 40 feet
		2,000	Seepage	Slurry Cutoff Wall to 100 feet
Sacramento Bypass Training Levee	3,000	3,000	Erosion	Bank Protection

Additionally, the William Stone lock structure will be closed and the Sacramento River Deep Water Ship Channel barge canal will be blocked from the Sacramento River via a new levee embankment and sheet pile wall. A coffer dam will be constructed on the east side of the lock structure, and the new levee and sheet pile wall will be built within the dry area. The new levee will permanently connect the North and South Basins. It will require the relocation of three utility poles, two storm drains, and the removal of concrete infrastructure.

Port North

The Port North levee work is scheduled as the final reach of the West Sacramento GRR Project, extending 4.9 miles west from the William Stone lock structure at the Sacramento River. Work through the levee reach generally involves the construction of flood walls through the Port of West Sacramento to alleviate overtopping concerns (see Figure 1).

Yolo Bypass

To address seepage and slope stability problems, slurry cutoff walls will be constructed at two points along the Yolo Bypass levee. A conventional open trench cutoff construction method will be used to install cutoff walls in two places to depths of 40 feet and 100 feet. The Yolo Bypass levee is scheduled as the fourth levee reach to be addressed in the West Sacramento GRR Project.

Sacramento Bypass Training Levee

Most of the south levee of the Sacramento Bypass was reconstructed as the CHP Academy Early Implementation Project in 2011. However, a 3,000-foot portion of the south levee that lies to the west of the CHP Academy Project is scheduled as the second levee reach to be addressed by the current West Sacramento GRR Project. Bank protection is proposed to address erosion issues.

South Basin Levee Reaches

Table 3 shows the extent to which each construction measure will occur within each levee reach in the South Basin. Refer to Figure 1 for the approximate location of each proposed improvement.

South Cross

The South Cross levee reaches west from the Sacramento River at the Riverview area of West Sacramento, to the Sacramento River Deep Water Ship Channel. Plans include a landside berm to address stability issues and a levee raise to address height concerns. It is scheduled as the eighth of the nine levee reaches to be addressed by construction under the project.

Sacramento River Deep Water Ship Channel East

The east levee along the Sacramento River Deep Water Ship Channel protects the South Basin from inundation. Noted deficiencies in the east levee are seepage, slope stability, and insufficient height. Slurry cutoff walls will be installed to address the seepage and slope stability issues. In reconstructing the levee prism to address height concerns, the irrigation ditch at the landside toe of the levee will be moved landward, and will be replaced by two 48-inch diameter pipes in the area adjacent to existing housing development. The Sacramento River Deep Water Ship Channel east levee is scheduled as the seventh levee reach for construction of the project.

Port South

The Port South levee has overtopping and seepage issues, as well as slope stability problems in a few areas. To alleviate the stability and seepage concerns, a seepage berm will be constructed. Also, relief wells will be added in certain areas to control additional seepage. The levee will be raised as well to address overtopping concerns. The Port South levee will be the sixth levee reach scheduled for construction in the project.

Sacramento River Deep Water Ship Channel West

The west levee along the Sacramento River Deep Water Ship Channel provides a barrier between the ship channel and the Yolo Bypass. As a worst-case scenario, levee deficiencies at various locations along nearly 19 miles of the levee will be addressed. Slurry cutoff walls and seepage berms will be constructed to control seepage issues, and the levee will be raised to address overtopping concerns. On the west side of the levee, facing the Yolo Bypass, rock slope protection will be used to address erosion concerns. The Sacramento River Deep Water Ship Channel west levee is scheduled as the fifth reach for construction in the project.

Table 3. The construction length, improvement, and construction measure of each levee reach within the South Basin of the West Sacramento General Reevaluation Report, City of West Sacramento, Yolo County, California (Corps 2014b).

South Basin Levee Reach	Length of Levee Reach (feet)	Length of Measure (feet)	Improvement	Measure
South Cross Levee	6,273	1,100	Stability/Height	Stability Berm Embankment Fill
		5,000	Seepage/Height	Relief Wells Embankment Fill
Deep Water Ship Channel East Levee	17,171	1,500	Seepage	Slurry Cutoff Wall to 120 feet
		7,100	Seepage	Slurry Cutoff Wall to 130 feet
		2,600	Height	Embankment Fill
Port South Levee	16,262	15,600	Height	Embankment Fill
		1,000	Seepage	Slurry Cutoff Wall to 70 feet
Deep Water Ship Channel West Levee	100,260	9,000	Height/Seepage	Slurry Cutoff Wall to 85 feet
		7,000	Height/Seepage	Slurry Cutoff Wall to 50 feet
		9,000	Height/Seepage	Slurry Cutoff Wall to 75 feet
		75,300	Height	Embankment Fill
		100,000	Erosion	Bank Protection
Sacramento River South Levee	31,000	31,000	Seepage/Erosion	Setback Levee Bank Protection Slurry Cutoff Wall to 80 feet 70-foot Wide Seepage Berm

<u>Sacramento River South – *The Southport Project*</u>

The Southport Project, an Early Implementation Project along the Sacramento River South levee, will be the first levee reach to be addressed in the project. Construction is scheduled to begin in 2015 by the city of West Sacramento, in advance of the overall West Sacramento GRR Project. The Southport Project is proposed to construct flood risk reduction measures along the Sacramento River South levee in order to provide 200-year level of performance consistent with the State mandate for urbanized areas, as well as to provide opportunities for ecosystem restoration and public recreation.

The Southport Project is divided into eight segments, A-G, from south to north (Appendix A). Table 4 outlines the construction measures to be built in each section.

Table 4. Levee remediation measures of the Southport Project portion of the West Sacramento GRR Project, West Sacramento, Yolo County, California.

Southport Segment	Length (linear feet)	Remediation Measures
A	4,830	Slurry cutoff wall
B	115	Slurry cutoff wall
	1,955	Slurry cutoff wall and seepage berm
	3,490	Setback levee, slurry cutoff wall, seepage berm, bank stabilization at levee breach
C	4,490	Setback levee, slurry cutoff wall, seepage berm, toe rock and bank stabilization at levee breaches
	940	Setback levee, slurry cutoff wall, seepage berm, bank stabilization at erosion sites, waterside toe rock upstream and downstream of erosion sites
D	1,985	Setback levee, slurry cutoff wall, waterside toe rock upstream of erosion sites
E	995	Setback levee and slurry cutoff wall
	2,297	Setback levee, slurry cutoff wall, and seepage berm
F	5,583	Setback levee, slurry cutoff wall, seepage berm, bank stabilization and waterside toe rock at decommissioned levee breach, waterside toe rock and bank stabilization at other decommissioned levee breach
G	2,795	Slurry cutoff wall and bank stabilization at erosion site

The Southport project involves the following elements:

- Construction of flood risk reduction measures, including seepage berms, slurry cutoff walls, setback levees, rock and biotechnical slope protection, and encroachment removal;
- Partial degrade of the existing levee, forming a decommissioned "remnant levee;"
- Construction of an offset floodplain area using setback levees, supplying about 160 acres in total for subsequent habitat restoration of riparian and floodplain habitats;
- Construction of breaches in the remnant levee to open up the offset areas to Sacramento River flows;
- Road construction;
- Drainage system modifications; and
- Utility line relocations.

The levee flood risk reduction measure footprint includes the following elements: a waterside O&M easement where available, the levee from toe to toe, a seepage berm, and the landside O&M easement. The waterside and landside O&M easements will be assumed to be 20 feet wide and unpaved. The landside O&M easement follows the toe of the levee or the landside toe of seepage berms, where present. The utility corridor is included largely within the Village Parkway right-of-way. In Segment G, where existing residences are close to the existing levee, the landside O&M easement will vary from about a few feet to 100 feet between the proposed flood risk reduction measure toe and the existing residential lot lines. In Segment A, the landside O&M easement coincides with South River Road. For segments where a suitable impermeable tie-in layer was not identified from the geotechnical explorations, a seepage berm will be constructed. Where a tie-in layer was located, a cutoff wall at the associated depth will be constructed. For levee reaches where a seepage berm will be constructed to address underseepage, a shallow cutoff wall also will be installed in lieu of an inspection trench.

A setback levee will be constructed in levee Segments B through F. A setback levee is an entirely new section of levee constructed at some distance behind the landside of the existing levee. The obsolete levee sections will remain in place and be breached to create and offset area containing two separate floodplains for the Sacramento River. The new section of levee will be tied into the existing levee to the south and north and become the Federal project levee. Once the foundation of the new setback is built up to a suitable elevation, a slurry cutoff wall will be constructed using either the conventional slot trench method or clamshell method.

The new levee section will be constructed to meet current design standards, including height and slope requirements. Levee slopes will be graded to a 3H:1V slope, and a crown at least 20 feet wide created. Topsoil will then be placed on the levee slopes and hydroseeded. For the purpose of levee inspection and emergency vehicle access, an aggregate base, all-weather levee-top patrol road will be constructed. Seepage berms for the Southport Project will vary from 50 to 100 feet in width. Lateral length will depend on seepage conditions along the area of identified levee deficiency.

Southport Project Bank Erosion Sites

Three bank erosion sites requiring repairs were identified in the project reaches along the Sacramento River; two sites are in Segment C and the third site is in Segment G (Appendix A). The Segment C sites will not be subject to the Corps vegetation policy, as they will be on the remnant levee; however, the Segment G site will be located on the Federal project levee and will comply with the vegetation policy. The repairs at all three sites are designed to protect against erosional forces that threaten levee stability, such as wind, waves, boat wake, and fluvial forces.

Southport Project Remnant Levee Sites

The two erosion sites on the remnant levee are C1 and C2. Once the setback levees for the Southport Project are complete, the existing levee in Segment C will no longer be part of the Federal project levee. Site C1 has a top length of 160 linear feet, while Site C2 has a length of 547 linear feet. Remediation at Site C1 will address a scour hole that has formed on the slope between elevations of -33 feet, North American vertical datum of 1988 (NAVD 88), and +11 feet NAVD 88, as well as slumping that has occurred at the base of the slope. Remediation at Site C2 will address general erosion problems that have been created by wave erosion.

<u>Design and Construction</u>: Erosion site repairs on the remnant levee are designed both to control erosion and to maintain existing vegetation and instream woody material. This will be accomplished by incorporating rock benches that serve as buffers against erosion while providing space for planting riparian vegetation and creating a platform to support aquatic habitat features (Appendix A). Rock will be placed onto the levee slope from the waterside by means of barges; one barge will hold the stockpile of rock to be placed, and a second barge will hold the crane that will place the rock on the channel slopes. A backhoe will be used from the bank to adjust the rock. Clean rock fill will be placed over existing riprap between elevations of -33 feet NAVD 88 and +5 feet NAVD 88, and type C graded stone will be placed over the clean rock fill in a 2.5-foot thick layer with a 2H:1V slope from the toe of the slope to an elevation of +7 feet NAVD 88. The clean rock fill and graded stone at the top of the erosion site will be placed to form a planting bench at an

elevation of +7 feet NAVD 88 to match the average annual low-water surface elevation, and the bench will have an average width of about 10 feet. At Site C1, stone will be placed at the upstream and downstream ends of the site to address problems created by a scour hole along the site.

After the rock is placed along the slope of the erosion sites, a 1-foot thick layer of 0.75-inch crushed clean rock will be placed at the upslope end of the stone bench to create a filter between the topsoil and the stone bench. Topsoil then will be placed above the newly constructed bench at a 3H:1V slope to meet the existing bank, and coir fabric will be placed over the soil to keep it in place. Topsoil will be placed from a barge, similar to the process for placing the rock. Pole plantings will be hand-placed in the planting bench between elevations of +7 feet NAVD 88 and +11.5 feet NAVD 88. Beaver fencing will be installed at the upslope and downslope extents of the topsoil installation. Instream woody material will be anchored along the remnant levee erosion sites to achieve at least 40% shoreline coverage, and placed between 1 and 3 feet below the elevation of the average annual low water surface. Instream woody material will likely come from trees removed in other portions of the project area, and will be selected based on suitability for the site. Existing vegetation and riprap at the erosion site will be retained.

The two erosion sites on the remnant levee are located on the outer bank of a bend in the river and are therefore subject to greater erosive forces. Rock will be placed along the toe of the bank (toe rock) at both sites, as well as upstream and downstream of the erosion sites to further protect the bank of the remnant levee. The toe rock will begin about 850 feet upstream of Site C1, will extend through both erosion sites, and will terminate about 300 feet downstream of Site C2. Portions of this area are currently riprapped, and the additional toe rock to be placed will be limited to areas where there is currently no rock below an elevation of +7 feet NAVD 88.

Southport Project Active Levee Erosion Site

Site G3 is located in Segment G and therefore will remain as part of the Federal project levee. Site G3 includes 410 linear feet of repairs to the top of the erosion scarp and the creation of a planting bench and vegetated slope to protect against boat wake and fluvial erosion.

The design, construction equipment, methods, and materials for Site G3 are similar to those described for Sites C1 and C2. However, Site G3 will require additional rock armoring and soil fill (up to elevation +25 feet NAVD 88) to repair the erosion scarp and meet Federal levee protection standards. The proposed design includes riprap toe protection, earth and rock fill to restore the levee prism between elevation -10 feet NAVD 88 and +25 feet NAVD 88, a soil-covered 10-foot-wide planting bench (10H:1V slope) and bank (3H:1V slope) planted with pole cuttings and large container plantings, and instream woody material anchored between 1 and 3 feet below the elevation of the average annual low water surface. The planting bench will be 15 feet outside the minimum levee template.

Southport Project Encroachment Removal

Levee standards for vegetation and encroachments require removing encroachments, such as structures, levee penetrations (e.g., pipes, conduits, cables), power poles, pump stations, and similar features, from the levee footprint. Encroachment removal includes demolition, relocation, retrofitting, or reconstruction as appropriate on a case-by-case basis. Existing pilings within the river at Oak Knoll Bend also will be removed.

Encroachment removal techniques will be implemented based on the needs of the specific encroaching feature. Smaller encroachments will be removed, relocated, or retrofitted by manual labor of small crews (about 2 to 10 workers) using hand tools. Larger encroachments require machinery such as an excavator, skid-steer, and bulldozer. The removal of sections of two-lane asphalt road will be required. Piling removal requires a barge with a crane for removal or cutting at the mud line. Dump trucks will be used for hauling and disposal of removed material at an offsite, permitted commercial source within 10 miles of the project area.

Southport Project Remnant Levee Degrade

With the construction of the setback levee, most of the decommissioned levee in Segments B through F will be degraded to provide additional borrow material for constructing seepage berms or for reclamation of other borrow areas. The remnant levee in Segment E will remain to maintain access to Sherwood Harbor Marina and Sacramento Yacht Club. Similarly, although the roadway will be removed up to the Sacramento Yacht Club, the levee will not be degraded on Segment F south of breach N2 to help protect the marinas during high flow events.

Prior to excavation, the area to be degraded will be cleared, grubbed, and stripped. The remnant levee will be degraded to an elevation of +30 feet NAVD 88, with a crown width of 20 feet and a landside slope of 3H:1V. Front-end loaders will load haul trucks with the excavated material. Haul trucks will transport the material to stockpile areas in the staging areas for later use for berms, or to borrow areas for use in site restoration. Material used for borrow area restoration will be spread evenly using motor graders and compactors. Disturbed areas will be planted as part of the offset area restoration plantings, and an unpaved O&M corridor will be established along the landside toe of the remnant segments.

Southport Project Levee Breaches

Portions of the remaining decommissioned levee will be breached to allow Sacramento River flows into two separate floodplain areas within the offset area during high flow events (Appendix A). The northern floodplain area breaches, from north to south, are North 1 (N1) and North 2 (N2) (both in Segment F), and the southern floodplain area breaches, from north to south, are South 1 (S1) (Segment C), South 2 (S2) (Segment C), and South 3 (S3) (Segment B). Construction of the breaches will occur during the summer–fall period to comply with Central Valley Flood Protection Board regulations. Both floodplain areas will be distinct from the existing Bees Lakes, which also will remain on the waterside of the new setback levee alignment.

Breaches S3 and N1 will be created in the third construction year and the remaining breaches will be completed 2 years later. Staggering the breaches will allow offset area restoration vegetation to establish before being exposed to flows. Until breaches S1, S2 and N2 are constructed, culverts will be installed at their proposed locations to drain the offset floodplain area. The culverts also will balance the hydraulic pressure on both sides of the degraded levee and to minimize fish stranding. Each culvert will be 54 inches in diameter and about 140 feet long. The culverts will be placed at about +7 NAVD in order to fully drain the offset floodplain area. To construct the breaches, the existing levee will be degraded with excavators to an elevation of +10 feet NAVD 88. Existing revetment in good condition will be retained below +10 NAVD 88. The breach shoulders will be armored with rock from the existing riprap on the waterside, over the degraded remnant levee crown, and down the landside slope. A 25-foot riprap apron then will extend out from the landside toe of the breach shoulder at an elevation of roughly +10 NAVD 88, as well as from the toe of the shoulder in the breach. All rock for the shoulder and apron armoring will be placed in a layer about 2.5 feet thick.

In-water construction activities are scheduled between July 1 and October 31, when water elevations in the Sacramento River along the project area are typically at the average annual low water elevation of +6.7 feet NAVD 88 to +7.1 feet NAVD 88. Installation of temporary cofferdams may be necessary prior to culvert installation to prevent river flows from entering the construction area. At a minimum, sandbags will be used to construct the cofferdam and water will be pumped out of the inundated construction area. Cofferdams will be constructed using sheet pile walls or other methods, and typically will extend up- and downstream of the end of the culverts to provide a temporary work area.

The upstream shoulder of breach N1 and the downstream shoulder of breach S3 have slightly different erosion control measures than the other breach shoulders. Breaches N1 and S3 are located at the sites where the new setback levee alignment deviates from the old, decommissioned levee alignment. Rock armoring will be placed on the slope of the waterside of the setback levee and will transition along the remnant levee segment.

On the waterside of the breaches, new riprap will be placed from the toe of the bank slope up to an elevation of +7 feet NAVD 88 in areas where the existing riprap is lacking. Breaches N1, N2, S1, and S2 also will have rock placed along portions of the base of the bank to further protect it from erosive forces. Coir fabric will be placed between elevations of +7 feet NAVD 88 and +10 feet NAVD 88, and will be planted with species suitable to create a vegetated bench. Coir fabric also will be placed in the zone between the edge of the +10 feet NAVD 88 elevation and the centerline of the breach, with jute netting continuing landward of the termination of the coir fabric for 100 feet. This area also will be planted with cuttings, rootstock, or container plants.

Rock will be placed onto the levee slope from atop the degraded levee, from the breach sill, from the waterside by means of barges, or by a combination of the three methods. Rock required within the channel, both below and slightly above the surface of the water at the time of placement, will be placed by a crane located on a barge and then spread by an excavator located on top of the levee or in the breach sill. Construction requires two barges—one barge to carry the crane and another to hold the stockpile of rock to be placed on the channel slopes—and one excavator located in the breach. Rock required on the upper portions of the slopes will be placed by an excavator located on top of the levee. Rock placement from atop the levee requires one excavator for each potential placement site. Loaders will haul rock from a permitted source within 25 miles of the project area and dump it within 100 feet of the levee breach. An excavator will move the rock from the stockpile to the waterside of the levee.

Southport Project Offset Floodplain Area Restoration

The offset floodplain area refers to the two expanded floodways located between the proposed setback levee and the decommissioned, remnant levee that will be created when portions of the existing levee are breached (Appendix A). Project activities in this area will include floodplain and riparian habitat restoration and borrow excavation. The offset floodplain areas will be planted to provide mitigation for vegetation removed as part of construction.

If suitable for reuse, excavated material will be used in construction of the setback levee and seepage berms. Following excavation, the offset area will be graded to allow the creation and restoration of riverine floodplain and riparian habitats. Excavation in the offset areas may require groundwater management, done by pumping water out of excavated areas.

After the first two levee breaches are constructed and before the final three breaches are made, restoration plantings will be established in the offset floodplain areas during the fall, winter, and spring. Swales will be constructed in both offset floodplain areas, and the surrounding areas will be graded to create drainage to the swales as river stages decrease. Temporary and permanent erosion control measures such as jute netting, coconut fiber with net, live brush mattresses, and native turf will be used as appropriate to protect graded areas.

After breaches N2, S1, and S3 are constructed, three permanent cellular berms will be built across the offset area, between the setback levee and the remnant levee. The berms will be downstream of breaches N1, S1, and S2, and will create separate cells that will have independent drainage once water levels drop below the crest of the cellular berms. Material excavated from the breaches will be used to construct the cellular berms and construct terrain features. Berms will have a top elevation of +20 feet, top width of 20 feet, and side slopes no steeper than 10H:1V; they will overtop once water levels reach +20.0 feet NAVD 88. Floodplain upstream and downstream of the berms will be graded to drain away from the berms and to the closest existing levee breach location. Elevations in the offset floodplain area will vary from about +7.0 feet NAVD 88 to +20.0 feet NAVD 88 in order to provide broad habitat variability for a range of environmental and hydrodynamic conditions.

Habitats in the offset floodplain areas will be upland grasslands, riparian forest, shaded riverine aquatic habitat, and seasonal wetlands. Plants selected for establishment of each of the target plant communities were based on how the plants associate in nature, and the elevations at which these plants were observed growing along the Southport levee. A vegetation stratification survey on the Southport levee conducted by ICF in March of 2012 helped further inform and refine the restoration target plant communities. In the survey, different species of plants were observed to favor different elevation ranges based on species preferences and adaptations. The restoration design intends to mimic this vegetative stratification. Vegetation communities will include emergent marsh, riparian willow scrub, riparian cottonwood forest, mixed riparian woodland, elderberry shrubs and associated native plants for valley elderberry longhorn beetle habitat, and grassland. Planting of the offset area will take place in the fall following finish-grading operations and construction of the flood control features. Features of the offset area that are not finished in any given year will be kept free of vegetation to keep future construction areas clear.

Both container plants and pole cuttings may be used and will be spaced at regular intervals throughout the offset floodplain areas. Both overstory and understory species will be installed to mimic the natural structure of riparian forests along the Sacramento River. Supplemental irrigation will be provided for several years during the 3-year plant establishment period and then discontinued; irrigation water could possibly be pumped from the river or from an adjacent water supply by agreement with the owner. To avoid trampling or disturbing the plantings during the establishment period, signs will be posted at appropriate intervals providing notice that access to the restoration areas is not allowed.

A network of seasonal wetland swales will be excavated within the offset floodplain area cells and will inundate during high-water events on the Sacramento River to provide habitat for special-status native fish species. The swales will be constructed to elevations that provide shallow, low-velocity, off-channel habitat in the spring during high-water periods. Floodplain inundation is expected to occur at the 1-year recurrence interval event at depths between 0.5 and 3 feet, and at the 2-year recurrence interval event at depths ranging from 9 to 12 feet. Swale margins will be gently sloping to maximize edge habitat during flood events. Instream woody material structures will be installed in some of the swales to provide cover from predators. In larger flood events during the winter and spring, the upper riparian terraces will be inundated and provide additional areas of habitat for fish as well as contribute to the productivity of the river ecology.

The created swales will have several connections to the main river channel at the breach locations in order to maximize connectivity and minimize potential stranding as floodwaters recede. The swales will fully dewater by early summer in a given year, on average, to discourage use by nonnative fish. Areas of upland grassland in the offset floodplain area will serve as potential floodplain rearing habitat for native fish during periods of high flows, as well as foraging habitat for raptors during periods of low water.

O&M access to the offset areas will be provided by O&M corridors at the waterside toe of the setback levee and by unpaved O&M roads that cross the cellular berms. At a minimum, turnaround areas will be located at the breach shoulders.

Southport Project Offset Area and Remnant Levee Revegetation
Revegetation of the offset areas and remnant levee is proposed as a means to mitigate for construction effects. The riparian willow scrub target plant community will be established in zones with proper soil hydrology, between +8 feet and +10 feet NAVD 88. In the offset area, riparian willow scrub will be established just upslope from the constructed swales in a band width varying from about 10 to 150 feet. On the remnant levee, riparian willow scrub will be established in a narrow band varying from about 5 to 20 feet in width outside of the canopy of the existing trees that will remain. The plants selected for the riparian willow scrub planting are intended to establish a self-sustaining mix of riparian scrub dominated by four species of willows. The plant material installed could be container grown plants, cuttings, or a mixture of both. The areas within the offset area will be seeded, and the areas on the remnant levee with established herbaceous cover will not be seeded.

Southport Project Road Construction, Marina Access, and Bees Lakes
Village Parkway will be extended southward from its current intersection with Lake Washington Boulevard to Gregory Avenue near the project area's southern extent, moving South River Road traffic to the landside of the Sacramento River South Levee and to the future Village Parkway alignment. The existing alignment of South River Road in Segment A will be retained, as will the railroad abutments at the southern end of Segment A. However, a detour or permanent realignment of South River Road will be constructed at the south end of Segment A to maintain access on South River Road south of the project area during and after construction. Access roads will be built in Segment B to connect residences to the new Village Parkway alignment. At the project's northern extent, South River Road will be demolished. Where practicable, culverts will be constructed in ditches that are crossed by proposed roadways. Drainage ditches will be constructed along both sides of the new Village Parkway alignment, with an average width of 5 feet.

To maintain access between Sherwood Harbor Marina and Sacramento Yacht Club, South River Road will continue in its current alignment on the existing levee at Segment E and a portion of Segment F. However, to maintain access to the marinas, two new roads will be routed over the levee crown, across the offset area, and the across the decommissioned levee. The two access roads will be constructed to the north and south of the Bees Lake area. While the embankments will not be part of the flood risk–reduction features, they will prevent hydraulic surface connectivity between Bees Lakes and the Sacramento River. Linden and Davis Roads will be connected to the new Village Parkway alignment to restore traffic circulation, and a cul-de-sac will be added at the end of Linden Road, past the intersection with Village Parkway.

Dual access ramps will be constructed along the levee alignment to provide O&M and emergency access to the levee-top patrol road. One ramp will be in Segment B where South River Road currently descends from the existing levee to meet Gregory Avenue; one ramp in Segment C; one ramp in Segment D at the terminus of Davis Road; one ramp In Segment F at the terminus of

Linden Road; and one ramp in Segment G near the northern end of the project alignment. Access to the levee-top patrol road also will be provided where the Sherwood Harbor Marina and Sacramento Yacht Club access road embankments cross the proposed setback levee crown. Access ramps will be gated and will have "no parking" signs.

Southport Project Construction Schedule

Construction of the Southport Project will occur in more than one annual construction season, with construction of flood risk–reduction measures beginning in April of 2015, and finishing in 2017. Construction and restoration of the offset floodplain area will continue after 2017, with final remnant levee breaches constructed in 2020. Some of the Village Parkway construction and utility relocations may occur earlier, but most of the work for those portions of the project will be done in 2015. A description of construction activities and tentative construction year is provided below.

<u>2015</u>:

- Village Parkway construction and utility relocation will be completed.
- Construction of the entire length of the new setback levee will begin with the foundation and working platform. Construction of the cutoff wall will follow if weather allows.

<u>2016</u>:

- The setback levee cutoff wall and remaining buildup of the setback levee will be constructed to a finished elevation of +40 feet NAVD 88.
- South River Road will be detoured at south end of Segment A.
- Seepage berms will be constructed following completion of the setback levee segments.
- Segment A and the southern portion of Segment B will be degraded to an elevation of +32 feet NAVD 88, and in Segment G the levee will be degraded to an elevation of +34.5 feet NAVD 88. Cutoff walls will then be constructed in these segments, tying into the setback levee cutoff walls in Segments B and F. The levee crown in Segment A and the southern portion of Segment B will then be built back up to a finished elevation of +39 feet NAVD 88, and the levee in Segment G will be built back up to a finished elevation of +40 feet NAVD 88. The slurry cutoff wall toe will be at an elevation of -5 feet NAVD 88 through Segments A, B, C, and D; at 0 feet NAVD 88 for Segments E, F, and the southern portion of G; and will be at -67 feet NAVD 88 for the remainder of Segment G.
- The remnant levee in Segments B, C, D, and F will be degraded to an elevation of +30 feet NAVD 88, and will have a 20-foot-wide crown. Remnant levee degrading will be concurrent with setback levee and seepage berm construction.
- Offset floodplain area grading will begin.
- Erosion site repairs at C1, C2, and G3 will be constructed.

<u>2017</u>:

- Offset area grading will be completed. Culverts will be installed through the remnant levee at breaches N2, S1, and S2 to allow Sacramento River water flow into the offset floodplain areas.
- Breaches N1 and S3 will be constructed.
- Offset area planting will begin.

<u>2018</u>:

- Offset area planting will continue.

<u>2019</u>:

- The three remaining breaches and the offset area cellular berms will be constructed, and the southern offset area will be contoured.

<u>2020</u>:

- Offset area planting will be completed.

At the end of each construction season, the levee system will be restored, at a minimum, to the level of flood risk–reduction performance existing at the project outset. During construction Years 1 and 2, "tie-ins" will be built connecting the existing levee to newly constructed segments, as needed. These tie-ins will be achieved by benching the existing levee and installing compacted lifts to completely bond the new and existing levee materials. During the flood season, maintenance of the flood risk–reduction structures will be undertaken by the maintaining agency, RD 900.

Southport Project Sources of Borrow Material

To meet borrow material demands for constructing the flood risk–reduction measures, multiple sources may be used, including the following.

- Embankment fill material excavated from the existing levee structure as part of construction.
- Material excavated from the offset areas.
- Material excavated from borrow sites located on open land within the city, or close to the city limits.
- Dredged material previously removed from the Sacramento River Deep Water Ship Channel (presently stockpiled on high-terrace, upland benches adjacent to the west of the channel).
- Material purchased from permitted commercial borrow locations within 20 miles of the project site (as described on pages 7-8).

Southport Project Vegetation Removal

Vegetation clearing activities entail removing larger woody vegetation, such as trees and shrubs. Grubbing activities consist of removing roots, and stripping activities requires excavating about 6 inches of organic material from the levee surface. Vegetation on the decommissioned levee segments along the Sacramento River levee will be retained where feasible, with the exception of the five breach locations. However, some vegetation will be removed as part of construction of the new setback levee, seepage berms, and the landside utility O&M corridor.

Southport Project Staging Areas and Equipment Access

Five staging areas are designated for the Southport Project. The staging areas are located on the landside of the levee at Segments C, D, and E, and occupy about 25.2 acres in total (Appendix A). Areas where seepage berms are proposed also may be used for staging until construction begins on the seepage berms. To facilitate project construction, temporary earthen ramps will be constructed to permit equipment access between the levee crown and each staging area. The earthen ramps will not affect any delineated water bodies and will be removed when construction is complete.

Southport Project Operations and Maintenance

Following construction of the Southport Project, only the rock slope protection, native vegetation, and other biotechnical features will be permanent. Anticipated O&M actions include regular visual inspections of the site, vegetation maintenance and irrigation for up to 3 years, and periodic repairs, as needed, to prevent or repair localized scour along the bank and rock toe of the site. The previously mentioned O&M activities that pertain to the project as a whole will also occur along Sacramento River South levee reach following the Southport Project construction.

Conservation Measures

As part of the West Sacramento GRR Project description, the Corps and WSAFCA have committed to implementing the following conservation measures to avoid and minimize potential effects on the snake, beetle, smelt, and smelt critical habitat. A number of measures will be applied to the entire project or specific actions, and other measures may be appropriate at specific locations within the study area. Avoidance activities to be implemented during final design and construction include, but are not limited to:

- Avoiding vegetation removal to the extent feasible.
- Avoiding, to the extent possible, grubbing and contouring activities.
- Identifying all habitats containing, or with a substantial possibility of containing, listed terrestrial, wetland, and plant species in the potentially affected project areas. To the extent practicable, efforts will be made to minimize effects by modifying engineering design to avoid potential direct and indirect effects.
- Incorporating sensitive habitat information within project bid specifications.
- Incorporating requirements for contractors to avoid identified sensitive habitats within project bid specifications.

General Conservation Measures

- The Corps will seek a variance exempting the Sacramento River levee reaches from vegetation removal as per ETL 1110-2-583 in the lower one-third of the waterside of the levee prior to final construction and design phase. Construction will require removal of vegetation on the upper two-thirds of the waterside and landside slope. Full ETL vegetation compliance will occur on the Sacramento and Yolo Bypasses, Yolo Bypass Toe Drain, South Cross Toe Drain, and the Sacramento River Deep Water Ship Channel, Barge Canal, and Port of West Sacramento levee reaches.
- The Corps will use a rock soil mixture (a 70:30 rock to soil ratio) to facilitate re-vegetation of the Sacramento River project sites that require bank protection work. The soil-rock mixture will be placed on top of the of the rock revetment along the Sacramento River levees to allow native riparian vegetation to be planted and ensure that shaded riverine aquatic habitat is replaced or enhanced.
- In addition to an approved vegetation variance, the Corps will avoid the removal of existing vegetation in the proposed project area. To the extent possible, disturbance or removal of trees or larger woody vegetation will be replaced onsite with native riparian species, except in the vegetation-free zone, as established in ETL 1110-2-583.
- Best management practices will be implemented to prevent slurry seeping out to the river and require a piping system on the landside.
- Construction materials such as portable equipment, vehicles, and supplies, will be stored at designated construction staging areas and barges, exclusive of any riparian and wetlands areas.

- All liquid chemicals and supplies will be stored at a designated impermeable membrane fuel and refueling station.
- Erosion control measures, including a Storm Water Pollution Prevention Program and a Water Pollution Control Program, will be implemented to minimize soil or sediment from entering the river. The measures shall be installed, monitored for effectiveness, and maintained throughout construction operations to minimize any effects to federally-listed fish and their designated critical habitat.
- Construction will be scheduled when listed terrestrial and aquatic species will be least likely to occur in the project area.
- Site access will be limited to the smallest area possible in order to minimize disturbance.
- Litter, debris, and unused materials will be removed from the project area daily. Such materials or waste will be deposited at an appropriate disposal or storage site.
- Any spills of hazardous materials will be cleaned up within 24 hours and reported to the resource agencies. Any such spills, and the success of the efforts to clean them up, shall also be reported in post-construction compliance reports.
- A Corps-appointed biologist will serve as the point-of-contact for any contractor who might incidentally take a living, or find a dead, injured, or entrapped threatened or endangered species. The representative shall be identified to the employees and contractors during an all employee education program conducted by the Corps.
- Screen any water pump intakes, as specified by NMFS and Service screening specifications. Water pumps will maintain an approach velocity of 0.2 feet per second or less when working in areas that may support delta smelt.

Giant Garter Snake Conservation Measures

The following measures will be implemented to minimize effects on giant garter snake habitat that occurs within 200 feet of any construction activity. These measures are based on Service guidelines for restoration and standard avoidance measures (Service 1997).

- **To the maximum extent possible, all construction activity within giant garter snake aquatic and upland habitat within 200 feet of aquatic habitat will be conducted during the snake's active period (May 1–October 1). During this time frame, potential for injury and mortality are lessened because snakes are actively moving and avoiding danger. The construction season is typically from April 15 to October 31, subject to weather and other conditions. Because some construction may extend into the giant garter snakes dormant period (October 2 to April 30), additional protective measures will be implemented at these locations. All of the following minimization measures must be implemented in order for work to continue past the October 1 deadline:**
    - **The Corps shall contact the Service on or before August 15, to determine if any additional measures are needed to minimize effects to the snake.**
    - **Work activities must commence on or before September 15.**
    - **A Service-approved biologist will be on-site daily to monitor all construction activities associated with the project throughout the entire extension period.**
    - **All emergent vegetation and vegetation within 200 feet of suitable aquatic habitat will be cleared prior to the giant garter snake**

hibernation period (i.e., vegetation clearing must be completed by October 1).

  - **Snake exclusion fencing must be completely installed prior to the October 1 deadline.**

- **Construction personnel will participate in a Service-approved worker environmental awareness program.**
- **Staging areas will be located at least 200 feet from suitable snake habitat;**
- **Any dewatered habitat will remain dry for at least 15 consecutive days after April 15 and prior to excavating or filling of the dewatered habitat;**
- **Vegetation clearing within 200 feet of the banks of suitable snake aquatic habitat will be limited to the minimum area necessary. Avoided snake habitat within or adjacent to the action area will be flagged and designated as an environmentally sensitive area, to be avoided by all construction personnel;**
- **The movement of heavy equipment within 200 feet of the banks of suitable snake aquatic habitat will be confined to designated haul routes to minimize habitat disturbance; and**
- **Prior to ground-disturbing activities within 200 feet of suitable habitat, a Service-approved biological monitor will conduct a preconstruction survey of suitable aquatic and upland habitat and inspect exclusion and orange barrier fencing to ensure they are both in good working order each morning. Should there be any interruption in work for greater than 2 weeks, a biologist will survey the project area again no later than 24 hours prior to the restart of work. If any snakes are observed within the construction area at any other time during construction the biological monitor will be contacted to survey the site for giant garter snakes. The biological monitor will have the authority to stop construction activities until appropriate corrective measures have been completed or it is determined that the snake will not be harmed. Giant garter snakes encountered during construction activities will be allowed to move away from construction activities on their own. If they are unable to move away on their own, trapped or injured, giant garter snakes will only be removed by Service-permitted personnel and will be placed in the nearest suitable habitat that is outside of the construction area. The biological monitor will immediately report these activities to the Service by phone and will provide a written account of the details of the incident within 24 hours.**
- **Snake habitat within 200 feet of construction activities will be designated as an environmentally sensitive area and delineated with signs or fencing. This area will be avoided by all construction personnel.**
- **To reduce the likelihood of snakes entering the construction area, exclusion fencing and orange barrier fencing will be installed along the portions of the construction area that are within 200 feet of suitable aquatic and upland habitat. The exclusion and barrier fencing will be installed during the active period for giant garter snakes to reduce the potential for injury and mortality during this activity.**
  - **The construction specifications will require a provision to retain a qualified biologist to identify the areas that are to be avoided during construction. Areas adjacent to the directly affected area required for construction, including staging and access, will be fenced off to avoid disturbance in these areas. Before construction, the contractor will work with the qualified biologist to identify the locations for the barrier fencing and will place flags or flagging around the areas to be protected to indicate the locations of the barrier fences. The protected area will be clearly identified on the construction specifications.**

Exclusionary fencing will be placed, at least 10 days prior to the beginning of ground disturbing activities after May 1 , to exclude giant garter snakes from entering areas where upland disturbance (borrow sites and levees) will occur during the active season (May 1 to October 1). The fencing will be installed the maximum distance practicable from the aquatic habitat areas.

- The barrier fencing will consist of 4-foot-tall erosion fencing buried at least 6–8 inches below ground level. The exclusion fencing will be commercial-quality, tightly-woven polypropylene fabric, orange in color, and 4 feet high (Tensor Polygrid or equivalent). The fencing will be tightly strung on posts with a maximum of 10-foot spacing. Prior to fencing installation, the fence line will be mowed (with a minimum height of 6 inches) in order to conduct a surface survey of potential burrows. Fence staking will be installed on the inside of the exclusion area. One-way escape funnels will be installed every 50 to 100 feet and sealed along the fence line to provide an escape for any giant garter snake that may be within the exclusion area. The fencing will enclose the entirety of the site, or additional exclusionary fencing can be extended 200 to 400 feet beyond the proposed entrance area.
- Barrier and exclusion fences will be inspected daily by a qualified biological monitor during ground-disturbing activities. Once all initial ground-disturbing activities are completed, the biological monitor will perform weekly checks of the site for the duration of construction in order to ensure that construction barrier fences and exclusion fences are in good order, trenches are being covered, project personnel are conducting checks beneath parked vehicles prior to their movement, and that all other required biological protection measures are being complied with. The biological monitor will document the results of monitoring on construction monitoring log sheets, which will be provided to the Service within 1 week of each monitoring visit. Monitoring will continue until project construction is complete or until the fences are removed, as approved by the biological monitor and the resident engineer. The biological monitor will be responsible for ensuring that the buffer area fences around giant garter snake habitat are maintained throughout construction. Biological inspection reports will be provided to the project lead and the Service.

- To avoid the entrapment of snakes, all excavated areas more than 1 foot deep will be provided with one or more escape ramps constructed of earth fill or wooden planks at the end of each workday. If escape ramps cannot be provided, then holes or trenches will be covered with plywood or other hard material. The biological monitor or construction personnel designated by the contractor will be responsible for thoroughly inspecting trenches for the presence of giant garter snakes at the beginning of each workday. If any snakes become trapped, the Service-approved biological monitor will be contacted to relocate the snake, and no work will occur in that area until approved by the biological monitor.

If any giant garter snake habitat is affected by construction, the following measures will be implemented to compensate for the habitat loss:

- Habitat temporarily affected for one season (155 acres of upland habitat disturbed for borrow in the Southport area, 5 acres of upland habitat on Sacramento Bypass

training levees, 5 acres of upland habitat on the Yolo Bypass levee, 20 acres of upland habitat on the Sacramento River Deep Water Ship Channel (DWSC) west levee, 10 acres of upland habitat on the DWSC east levee, 4 acres of upland habitat on the South Cross levee, and 2 acres of aquatic habitat along the Port South) will be restored after construction by applying appropriate erosion control techniques and replanting/ seeding with appropriate native plants. If for any reason construction extends into another active season the Corps will replace the habitat on-site and purchase credits at a ratio of 1:1 at a Service approved conservation bank.

- **Habitat temporarily affected three or more seasons will be restored and twice as much habitat will be created.**
- **Habitat permanently affected (10 acres of aquatic habitat along the DWSC east levee, 10 acres of aquatic habitat along the South Cross levee, 2.24 acres of upland habitat in the setback area and 1 acre of aquatic habitat along the Port South levee) will be compensated for through the purchase of 69.72 acres of credits at a Service approved conservation bank.**
- **One year of monitoring will be conducted for the 201 acres that are temporarily affected.**
- **The Corps will purchase credits at a conservation bank prior to any permanent disturbance of giant garter snake habitat**
- **A biological monitor will be on-site during all ground disturbing activities at borrow site 2.**

Conservation Measures for the Southport Project

Because the Southport Project along the Sacramento River South levee is scheduled as an Early Implementation Project it will be the first construction project under the West Sacramento GRR Project, and therefore conservation measures have been established in greater detail. The Corps and WSAFCA have committed to implementing the following conservation measures as part of the Southport Project.

Southport Project General Conservation Measures

Conduct mandatory biological awareness training for all project personnel and implement general requirements:

Before any ground-disturbing work (including vegetation clearing and grading) occurs in the Southport Project action area, a Service-approved biologist will conduct a mandatory biological resources awareness training for all construction personnel about Federally listed species that could potentially occur onsite. The training will include the natural history, representative photographs, and legal status of each Federally listed species and avoidance and minimization measures to be implemented. Proof of personnel attendance will be provided to the Service within 1 week of the training. If new construction personnel are added to the Southport Project, the contractor will ensure that the new personnel receive the mandatory training before starting work. The subsequent training of personnel can include videotape of the initial training and/or the use of written materials rather than in-person training by a biologist. Elements of the training that will be followed by construction personnel are listed below:

- Where suitable habitat is present for listed species, WSAFCA will clearly delineate the construction limits through the use of survey tape, pin flags, orange barrier fencing, or other means, and prohibit any construction-related traffic outside these boundaries.

- Project-related vehicles will observe the posted speed limit on hard-surfaced roads and a 10-mile-per-hour speed limit on unpaved roads during travel in the project construction area.
- Project-related vehicles and construction equipment will restrict off-road travel to the designated construction areas.
- All food-related trash will be disposed of in closed containers and removed from the project construction area at least once per week during the construction period. Construction personnel will not feed or otherwise attract fish or wildlife to the project area.
- No pets or firearms will be allowed in the project area.
- To prevent possible resource damage from hazardous materials, such as motor oil or gasoline, construction personnel will not service vehicles or construction equipment outside designated staging areas.
- Any worker who inadvertently injures or kills a federally-listed species or finds one dead, injured, or entrapped will immediately report the incident to the biological monitor and construction foreman. The construction foreman will immediately notify WSAFCA, who will provide verbal notification to the Service within 1 working day. WSAFCA will follow up with written notification to the Service within 5 working days. The biological monitor will follow up with WSAFCA to ensure that the wildlife agencies were notified.

Prepare and implement a Stormwater Pollution Prevention Plan

Because ground disturbance would be greater than 1 acre, WSAFCA will obtain coverage under the U.S. Environmental Protection Agency's (EPA's) National Pollutant Discharge Elimination System (NPDES) general construction activity stormwater permit. The Central Valley Regional Water Quality Control Board administers the NPDES stormwater permit program in Yolo County. Obtaining coverage under the NPDES general construction activity permit generally requires that the project applicant prepare a stormwater pollution prevention plan that describes the Best Management Practices that will be implemented to control accelerated erosion, sedimentation, and other pollutants during and after project construction. The SWPPP will be prepared prior to commencing earth-moving construction activities.

The plan likely will include, but not be limited to, one or more of the following standard erosion and sediment control practices:

- The construction contractor will conduct all construction activities during the typical construction season to avoid ground disturbance during the rainy season. To the extent possible, equipment and materials will be staged in areas that have already been disturbed. No equipment or materials would be stored in the floodway during the flood season.
- The construction contractor will minimize ground disturbance and the disturbance/destruction of existing vegetation. This will be accomplished in part through the establishment of designated equipment staging areas, ingress and egress corridors, and equipment exclusion zones prior to the commencement of any grading operations.
- Grading spoils generated during the construction will be temporarily stockpiled in staging areas. Silt fences, fiber rolls, or similar devices will be installed around the base of the temporary stockpiles to intercept runoff and sediment during storm events. If necessary, temporary stockpiles may be covered with an appropriate geotextile to increase protection from wind and water erosion.
- The construction contractor may install silt fences, fiber rolls, or similar devices to prevent sediment-laden runoff from leaving the construction area.
- The construction contractor may install silt fences, drop inlet sediment traps, sandbag barriers, and/or other similar devices.

- The construction contractor will install structural and vegetative methods to permanently stabilize all graded or otherwise disturbed areas once construction is complete. Structural methods may include the installation of biodegradable fiber rolls and erosion control blankets. Vegetative methods may involve the application of organic mulch and tackifier and/or the application of an erosion control native seed mix.

Prepare and Implement a Bentonite Slurry Spill Contingency Plan (Frac-Out Plan)

Before excavation begins, WSAFCA will ensure the contractor will prepare and implement a bentonite slurry spill contingency plan (BSSCP) for any excavation activities that use pressurized fluids (other than water). If the contractor prepares the plan, it will be subject to approval by the Corps, NMFS, and WSAFCA before excavation can begin. The BSSCP will include measures intended to minimize the potential for a frac-out ("fracture-out event") associated with excavation and tunneling activities; provide for the timely detection of frac-outs; and ensure an organized, timely, and minimum-effect response in the event of a frac-out and release of excavation fluid (bentonite). The BSSCP will require, at a minimum, the following measures:

- If a frac-out is identified, all work will stop, including the recycling of the bentonite fluid. In the event of a frac-out into water, the location and extent of the frac-out will be determined, and the frac-out will be monitored for 4 hours to determine whether the fluid congeals (bentonite will usually harden, effectively sealing the frac-out location).
- NMFS, CDFW, and the Central Valley Regional Water Quality Control Board will be notified immediately of any spills and will be consulted regarding clean-up procedures. A Brady barrel will be on site and used if a frac-out occurs. Containment materials, such as straw bales, also will be on site prior to and during all operations, and a vacuum truck will be on retainer and available to be operational on site within a 2-hour notice. The site supervisor will take any necessary follow-up response actions in coordination with agency representatives. The site supervisor will coordinate the mobilization of equipment stored at staging areas (e.g., vacuum trucks), as needed.
- If the frac-out has reached the surface, any material contaminated with bentonite will be removed by hand to a depth of 1 foot, contained, and properly disposed of, as required by law. The drilling contractor will be responsible for ensuring that the bentonite is either properly disposed of at an approved Class II disposal facility or properly recycled in an approved manner.
- If the bentonite fluid congeals, no other actions, such as disturbance of the streambed, will be taken that potentially would suspend sediments in the water column.
- The site supervisor has overall responsibility for implementing this BSSCP. The site supervisor will be notified immediately when a frac-out is detected. The site supervisor will be responsible for ensuring that the biological monitor is aware of the frac-out; coordinating personnel, response, cleanup, and regulatory agency notification and coordination to ensure proper clean-up; coordinating disposal of recovered material; and timely reporting of the incident. The site supervisor will ensure all waste materials are properly containerized, labeled, and removed from the site to an approved Class II disposal facility by personnel experienced in the removal, transport, and disposal of drilling mud.
- The site supervisor will be familiar with the contents of this BSSCP and the conditions of approval under which the activity is permitted to take place. The site supervisor will have the authority to stop work and commit the resources necessary to implement this plan. The site supervisor will ensure that a copy of this plan is available onsite and accessible to all construction personnel. The site supervisor will ensure that all workers are properly trained and familiar with the necessary procedures for response to a frac-out prior to the commencement of excavation operations.

Prepare and Implement a Spill Prevention, Control, and Counter-Measure Plan

A spill prevention, control, and counter-measure plan (SPCCP) is intended to prevent any discharge of oil into navigable water or adjoining shorelines. WSAFCA or its contractor will develop and implement an SPCCP to minimize the potential for and effects from spills of hazardous, toxic, or petroleum substances during construction and operation activities. The SPCCP will be completed before any construction activities begin. Implementation of this measure will comply with state and Federal water quality regulations. The SPCCP will describe spill sources and spill pathways in addition to the actions that will be taken in the event of a spill (e.g., an oil spill from engine refueling will be immediately cleaned up with oil absorbents). The SPCCP will outline descriptions of containments facilities and practices such as double-walled tanks, containment berms, emergency shutoffs, drip pans, fueling procedures, and spill response kits. It will describe how and when employees are trained in proper handling procedure and spill prevention and response procedures. WSAFCA will review and approve the SPCCP before onset of construction activities and routinely inspect the construction area to verify that the measures specified in the SPCCP are properly implemented and maintained. WSAFCA will notify its contractors immediately if there is a noncompliance issue and will require compliance. If a spill is reportable by regulation, the contractor's superintendent will notify WSAFCA, and WSAFCA will take action to contact the appropriate safety and cleanup crews to ensure that the SPCCP is followed. If an appreciable spill occurs and results determine that project activities have adversely affected surface or groundwater quality, a detailed analysis will be performed by a registered environmental assessor or professional engineer to identify the likely cause of contamination. This analysis will conform to American Society for Testing and Materials standards and will include recommendations for reducing or eliminating the source or mechanisms of contamination. Based on this analysis, WSAFCA and its contractors will select and implement measures to control contamination, with a performance standard that surface water quality and groundwater quality must be returned to baseline conditions.

Monitor Turbidity in Adjacent Water Bodies

WSAFCA or its contractor will monitor turbidity in the adjacent water bodies, where applicable criteria apply, to determine whether turbidity is being affected by construction and ensure that construction does not affect turbidity levels, which ultimately increase the sediment loads. The Water Quality Control Plan for the Central Valley Regional Water Quality Control Board (Basin Plan) contains turbidity objectives for the Sacramento River. WSAFCA or its contractor will monitor ambient turbidity conditions upstream during construction and adhere to the Surface Water Quality Ambient Monitoring Program requirements for turbidity monitoring. Monitoring will continue approximately 300 feet downstream of construction activities to determine whether turbidity is being affected by construction. Grab samples will be collected at a downstream location that is representative of the flow near the construction site. If there is a visible sediment plume being created from construction, the sample will represent this plume. Monitoring will occur hourly when construction encroaches into the Sacramento River. If construction does not encroach into the river, the monitoring will occur once a week on a random basis. If turbidity limits exceed Basin Plan standards, construction-related earth-disturbing activities will slow to a point that results in alleviating the problem. WSAFCA will notify the Central Valley Regional Water Quality Control Board of the issue and provide an explanation of the cause.

Prepare and implement a Mitigation and Monitoring Plan (MMP)

A draft MMP for the restoration areas is being developed and will be approved by the Corps, NMFS, Service, and CDFW before implementation of the Southport Project. The restoration objectives of the plan are listed below:

- Provide compensatory mitigation credits for effects on protected land cover-types and to special-status species and potential habitat for these species.
- Maximize shaded riverine aquatic cover/nearshore habitat, over and above current erosion stabilization efforts using biotechnical methods.
- Enhance setback ecological values using topographic and vegetation/habitat heterogeneity.
- Restore portions of the historic Sacramento River floodplain (i.e., waters of the United States).
- Restore riparian and oak woodland habitat on the restored floodplain that will create continuous habitat corridors for fish and wildlife movement.
- Design habitat features to minimize future maintenance obligations (e.g., reduce opportunities for sediment and debris accumulation).
- Design floodplain planting and vegetation management schemes to avoid undesirable hydraulic and sediment transport effects to the offset levee and offset area.
- Comply with current Corps levee vegetation policy to balance habitat needs with flood management objectives.

The monitoring objectives of the MMP are listed below:

- Monitor and evaluate the hydrologic and hydraulic performance of the restored floodplain relative to the ecological design criteria for the target species.
- Monitor and evaluate the success of the riparian/floodplain plantings and other habitat features in compensating, restoring, or enhancing fish and wildlife habitat values on the levee slopes and offset areas.
- Monitor and evaluate the effectiveness of the grading and drainage features in preventing fish stranding.
- Monitor the occurrence and extent of potential sedimentation and scour that may compromise the success of the habitat restoration and mitigation components of the project.

Valley Elderberry Longhorn Beetle Conservation Measures for the Southport Project

Conservation measures for beetle for the Southport Project are based on the Service's Conservation Guidelines (Service 1999a).

<u>Fence Elderberry Shrubs to be Protected and Monitor Fencing during Construction</u>: Elderberry shrubs and clusters within 100 feet of the construction area that will not be removed will be protected during construction. A qualified biologist (i.e., with elderberry/beetle experience), under contract with WSAFCA, will mark the elderberry shrubs and clusters that will be protected during construction. Orange construction barrier fencing will be placed at the edge of the respective buffer areas. The buffer area distances will be proposed by the biologist and approved by Service. No construction activities will be permitted within the buffer zone other than those activities necessary to erect the fencing. Signs will be posted every 50 feet along the perimeter of the buffer area fencing. The signs will contain the following information:
"This area is habitat of the valley elderberry longhorn beetle, a threatened species, and must not be disturbed. This species is protected by the Endangered Species Act of 1973, as amended. Violators are subject to prosecution, fines, and imprisonment."

In some cases, where the elderberry shrub dripline is within 10 feet of the work area, k-rails will be placed at the shrub's dripline to provide additional protection to the shrub from construction equipment and activities. Temporary fences around the elderberry shrubs and k-rails at shrub driplines will be installed as the first order of work. Temporary fences will be furnished, constructed, maintained, and later removed, as shown on the plans, as specified in the special provisions, and as directed by the project engineer. Temporary fencing will be 4 feet high, commercial-quality woven polypropylene, and orange in color.

Buffer area fences around elderberry shrubs will be inspected weekly by a qualified biological monitor during ground-disturbing activities and monthly after ground-disturbing activities until project construction is complete or until the fences are removed, as approved by the biological monitor and the resident engineer. The biological monitor will be responsible for ensuring that the contractor maintains the buffer area fences around elderberry shrubs throughout construction. Biological inspection reports will be provided to the project lead and Service.

Conduct Stem Counts Prior to Elderberry Shrub Transplantation: Surveys of elderberry shrubs to be transplanted will be conducted by a qualified biologist prior to transplantation. The biologist will survey the area surrounding the shrub to be transplanted to ensure that there are not additional elderberry shrubs that need to be removed. Surveys will consist of counting and measuring the diameter of each stem at ground level and examining elderberry shrubs for the presence of beetle exit holes. Survey results and an analysis of the number of elderberry seedlings/cuttings and associated native plants based on the survey results will be submitted to Service. Elderberry seedlings/cuttings and associated native plants will be planted prior to transplantation of elderberry shrubs. The data collected during the surveys prior to transplantation will be used to determine if compensation requirements or take limits are being exceeded, and if additional plantings are necessary. Because construction of the Southport project will occur over multiple years, elderberry survey data for each year will be used to rectify any discrepancies in compensation and to ensure full compensation of effects on the beetle. Surveys for the beetle are valid for a period of 2 years (Service 1999a).

Water the construction area to control dust: The construction contractor will ensure that the project construction area will be watered as necessary to prevent dirt from becoming airborne and accumulating on elderberry shrubs within the 100–foot buffer.

Compensate for direct effects on valley elderberry longhorn habitat: Before construction begins, compensation will be implemented for direct effects on elderberry shrubs by transplanting shrubs that cannot be avoided to a Service-approved conservation area. Elderberry seedlings or cuttings and associated native species will also be planted in the conservation area. Each elderberry stem measuring 1 inch or greater in diameter at ground level that is adversely affected will be replaced in the conservation area, with elderberry seedlings or cuttings at a ratio ranging from 1:1 to 8:1 (new plantings to affected stems). The numbers of elderberry seedlings/cuttings and associated riparian native trees/shrubs to be planted as replacement habitat are determined by stem size class of affected elderberry shrubs, presence or absence of exit holes, and whether the shrub lies in a riparian or non-riparian area. Stock of either seedlings or cuttings will be obtained from local, Service-approved sources. At the discretion of the Service, shrubs that are unlikely to survive transplantation because of poor condition or location, or a plant that will be extremely difficult to move because of access problems, may be exempted from transplantation. In cases in which transplantation is not possible, minimization ratios will be increased to offset the additional habitat loss.

The relocation of elderberry shrubs will be conducted according to Service-approved procedures outlined in the Conservation Guidelines (Service 1999a). Elderberry shrubs within the project construction area that cannot be avoided will be transplanted during the plant's dormant phase, which is November through the first 2 weeks of February. A qualified biological monitor will remain onsite while the shrubs are being transplanted.

Proposed Conservation Area

About 120 acres of riparian habitat in the Offset floodplain area will be restored or enhanced as part of the project implementation. Based on the Conservation Guidelines (Service 1999a), a total of 13.51 acres of the floodplain will be riparian habitat required for beetle compensation plantings for the Southport Project.

Evidence of the beetle occurrence in the conservation area, the condition of the elderberry shrubs in the conservation area, and the general condition of the conservation area itself will be monitored over a period of 10 consecutive years or for 7 years over a 15-year period from the date of transplanting. Monitoring reports will be provided to the Service in each of the years in which monitoring is required. As specified in the Conservation Guidelines, the report will include information on timing and rate of irrigation, growth rates, and survival rates and mortality.

To meet the success criteria specified in the Conservation Guidelines, a minimum survival rate of 60% of the original number of elderberry replacement plantings and associated native plants must be maintained throughout the monitoring period.

Action Area

The action areas is defined in 50 CFR § 402.02, as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." For the purposes of the effects assessment, the action area encompasses the Sacramento River from the Sacramento Bypass downstream to the South Cross Levee, the Sacramento Deep Water Ship Channel and the Port of West Sacramento, and the Sacramento and Yolo Bypasses (Figure 1).

The City of West Sacramento is bisected into two basins by the Sacramento River Deep Water Ship Channel and the Port of West Sacramento, and is contained within the levees of the West Sacramento GRR Project. The north basin encompasses 6,100 acres, while the south basin is 6,900 acres. Potential borrow areas, transportation routes, and staging areas have been identified within the city, as well as within 20 miles of West Sacramento. The potential borrow areas identified in Figure 2 are also part of the action area.

The action area also includes the perennial waters extending 200 feet perpendicular from shorelines adjacent to construction areas, and 1,000 feet downstream of the in-water construction areas. These distances represent the extent to which turbidity and sedimentation from the West Sacramento GRR Project may affect the waters.

Analytical Framework for the Jeopardy and Adverse Modifications Determinations

Jeopardy Determination

In accordance with policy and regulation, the jeopardy analysis in this biological opinion relies on four components: (1) the Status of the Species, which evaluates snake, beetle, and smelt range-wide conditions, the factors responsible for these conditions, and the survival and recovery needs of each species; (2) the Environmental Baseline, which evaluates the condition of the snake, beetle, and smelt in the action area, the factors responsible for these conditions, and the relationship of the action area to the survival and recovery of each species; (3) the Effects of the Action, which determines the direct and indirect effects of the proposed Federal action and the effects of any interrelated or interdependent activities on the snake, beetle, and smelt; and (4) the Cumulative

Effects, which evaluates the effects of future, non-Federal activities in the action area on the snake, beetle, and smelt.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the current status of the snake, beetle, and smelt, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of recovery of each species in the wild.

The jeopardy analysis in this biological opinion places an emphasis on consideration of the range-wide survival and recovery needs of the snake, beetle, smelt, as well as the role of the action area in the survival and recovery of each species as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Adverse Modification Determination

This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.2. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to critical habitat.

In accordance with policy and regulation, the adverse modification analysis in this biological opinion relies on four components: (1) the Status of the Critical Habitat, which evaluates the range-wide condition of critical habitat for the smelt in terms of primary constituent elements (PCE)s, the factors responsible for that condition, and the intended recovery function of the critical habitat at the provincial and range-wide scale; (2) the Environmental Baseline, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; (3) the Effects of the Action, which determines the direct and indirect effects of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units and; (4) Cumulative Effects which evaluates the effects of future, non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

For purposes of the adverse modification determination, the effects of the proposed Federal action on smelt critical habitat are evaluated in the context of the range-wide condition of the critical habitat at the provincial and range-wide scales, taking into account any cumulative effects, to determine if the critical habitat range-wide will remain functional (or will retain capable habitat) to serve its intended recovery role for the smelt.

The analysis in this biological opinion places an emphasis on using the intended range-wide recovery function of smelt critical habitat and the role of the action area relative to that intended function as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the adverse modification determination.

Status of the Species

Giant Garter Snake

Please refer to the Giant Garter Snake (*Thamnophis gigas*) 5-year Review: Summary and Evaluation for the current status of the species (Service 2006).

Environmental Baseline

Suitable habitat for the snake exists along the western border of both the North and South Basins of the West Sacramento GRR Project. In the North Basin, some additional suitable habitat can be found along the Sacramento Bypass. In the South Basin, drainages along the toe of the South Cross Levee may also provide habitat for the snake. However, most of the developed and undeveloped lands within the City of West Sacramento do not provide suitable habitat for the snake.

There are 28 occurrence records of the snake within 5 miles of the City of West Sacramento (CDFW 2014b). The closest occurrences are about 1.5 miles west of the Sacramento Bypass Training Levee, while 11 occurrences are to the north in the Natomas Basin, across the Sacramento River from West Sacramento. There are 77 CNDDB occurrences within 10 miles of West Sacramento (CDFW 2014b). Seven of the occurrence records within 10 miles of West Sacramento are across the Sacramento River and southeast of the City of Sacramento, near Elk Grove. Giant garter snakes are apparently absent from larger rivers, and from wetlands with sand, gravel, or rock substrates (R. Hansen 1980; Rossman and Stewart 1987; Brode 1988; G. Hansen 1988; Brode and Hansen 1992). Potential snake upland habitat is generally considered upland habitats within 200 feet of snake aquatic habitat. The Sacramento Bypass to the north, the Yolo Bypass to the west, and the South Cross Levee drainage canal to the south of the action area do provide suitable habitat for the snake. In the North Basin, work along the Sacramento Bypass Training Levee and Yolo Bypass Levees will border the Yolo Bypass, an area of agricultural and natural wetlands that provides suitable aquatic snake habitat. In the South Basin, work along the South Cross Levee, and along with the Sacramento Bypass west levee can provide suitable upland snake habitat. The Sacramento River generally does not offer suitable habitat.

Valley Elderberry Longhorn Beetle

For the most recent comprehensive assessment of the range-wide status of the beetle, please refer to the *Withdrawal of the Proposed Rule to Remove the Valley Elderberry Longhorn Beetle from the Federal List of Endangered and Threatened Wildlife; Proposed Rule, Withdrawal* (Service 2014a).

Environmental Baseline

The majority of lands within North and South Basins of West Sacramento are urban and suburban lands in private ownership. Suitable habitat for the beetle (i.e., elderberry shrubs) occurs throughout the City of West Sacramento. Although the status of the beetle and its habitat on most of these private lands is unknown, there are documented occurrences of beetles in both the North and South Basins (CDFW 2014b). In the South Basin, occurrence number 208 near river mile 52 of the Sacramento River, and occurrence number 209 along a railroad access north of Davis road, have identified both male and female beetles. At occurrence number 209, one female was observed laying eggs in 2006 (CDFW 2014b). In the North Basin, occurrences 18, 28, 29, and 56 have all documented elderberry shrubs with exit holes in stems, a sign of beetle presence.

Delta Smelt

Listing Status

The Service proposed to list the smelt as threatened with proposed critical habitat on October 3, 1991 (Service 1991). The Service listed the smelt as threatened on March 5, 1993, and designated critical habitat for this species on December 19, 1994 (Service 1994). The smelt was one of eight fish species addressed in the Recovery Plan for the Sacramento–San Joaquin Delta Native Fishes

(Service 1995). This recovery plan is currently under revision. A 5-year status review of the smelt was completed on March 31, 2004 (Service 2004). The 2004 review affirmed the need to retain the smelt as a threatened species. A 12-month finding on a petition to reclassify the delta smelt was completed on April 7, 2010 (Service 2010). After reviewing all available scientific and commercial information, the Service determined that re-classifying the smelt from a threatened to an endangered species was warranted but precluded by other higher priority listing actions (Service 2010).

Distribution

The smelt is endemic to the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta) in California, and is restricted to the area from San Pablo Bay upstream through the Delta in Contra Costa, Sacramento, San Joaquin, Solano, and Yolo counties (Moyle 2002). Their range extends from San Pablo Bay upstream to Verona on the Sacramento River and Mossdale on the San Joaquin River. The smelt was formerly considered to be one of the most common pelagic fish in the upper Sacramento-San Joaquin Estuary.

Description

Delta smelt are a small, slender bodied fish of the Osmeridae (smelts) (Moyle 2002). They are nearly translucent with a steely-blue sheen to their sides and a pronounced odor reminiscent of cucumber (Moyle 2002). Although delta smelt have been recorded to reach lengths of up to 120 mm (4.7 in) (Moyle 2002), catch data from 1992 - 2004 showed mean fork length to be 54.1 ± .01 mm (Bennett 2005; Sweetnam 1999). Delta smelt are also identifiable by their relatively large eye to head size (Moyle 2002) and their small, translucent adipose fin located between the dorsal and caudal fins. Occasionally one chromatophore may be found between the mandibles, but most often there is none (Moyle 2002).

The delta smelt is one of six species currently recognized in the Hypomesus genus (Bennett 2005). Genetic analyses have confirmed that delta smelt presently exists as a single intermixing population (Stanley et al. 1995; Trenham et al. 1998; Fisch et al. 2011). Within the genus, delta smelt are most closely related to surf smelt (*H. pretiosis*), a species common along the western coast of North America. The wakasagi *(H. nipponensis*), an anadromous western Pacific smelt species introduced to Central Valley reservoirs in 1959, is thought to be seasonally sympatric with the delta smelt in the estuary (Trenham et al. 1998). Despite morphological similarities, allozyme studies have demonstrated that wakasagi and delta smelt are genetically distinct and presumably derived from different marine ancestors (Stanley et al. 1995).

Life History

Adult delta smelt spawn during the late winter and spring months, with most spawning occurring during April through mid-May (Moyle 2002). Spawning occurs primarily in sloughs and shallow edge areas in the Delta and has been recorded in Suisun Marsh and the Napa River (Moyle 2002). Most spawning occurs at temperatures between 12-18°C. Spawning may occur at temperatures up to 22°C, but hatching success of the larvae is very low (Bennett 2005). Fecundity of females ranges from about 1,200 to 2,600 eggs, and is correlated with female size (Moyle 2002). In captivity, females survive after spawning and develop a second clutch of eggs (Mager et al. 2004) and field collections of ovaries containing eggs of different size and stage indicate that this also occurs in the wild (Adib-Samii 2008). While most adults do not survive to spawn a second season, a small percentage do (<5 percent) (Moyle 2002; Bennett 2005) and are typically larger (90-110 mm Standard Length [sdl]). These females may contribute disproportionately to the population's egg supply (Moyle 2002 and references therein) since two-year-old females may have 3-6 times as many ova as first year spawners.

The locations in the Delta where newly hatched larvae are present most likely indicates spawning occurrence and most of what is known about delta smelt spawning habitat in the wild is inferred from the location of spent females and young larvae captured in the DFW's Spring Kodiak Trawl (SKT) (CDFW 2014a) and 20-mm Survey, respectively. In the laboratory, delta smelt spawned at night (Baskerville-Bridges et al. 2000; Mager et al. 2004). Other smelts, including marine beach spawning species and estuarine populations are secretive spawners, entering spawning areas during the night and leaving before dawn. If this behavior is exhibited by delta smelt, then delta smelt distribution based on the SKT, which is conducted during daylight hours in offshore habitats, may reflect general regions of spawning activity, but not actual spawning sites.

Delta smelt spawning has only been directly observed in the laboratory. Consequently, what is known about the mechanics of smelt spawning is derived from laboratory observations and observations of related smelt species. Delta smelt eggs are 1 millimeter diameter and are adhesive and negatively buoyant (Moyle 2002; Mager et al. 2004; Wang 1986; Wang 2007). Laboratory observations indicate that delta smelt are broadcast spawners, discharging eggs and milt close to the bottom over substrates of sand and/or pebble in current (DWR and Reclamation 1994; Brown and Kimmerer 2002; Lindberg et al. 1997; Wang 2007). Spawning over gravel or sand can also aid in the oxygenation of smelt eggs and eggs that are laid in silt or muddy substrates might get buried or smothered, preventing their oxygenation from water flow (Lindberg pers. comm. 2011). The eggs of surf smelts and other beach spawning smelts adhere to sand particles, which keeps them negatively buoyant but not immobile, as the sand may "tumble" them with water currents and turbulence (Hay 2007). It is not known whether delta smelt eggs "tumble incubate" in the wild, but tumbling of eggs may moderately disperse them, which might reduce predation risk within a localized area.

Mager et al. (2004) reported that embryonic development to hatching takes 11-13 days at 14-16° C for delta smelt, and Baskerville-Bridges et al. (2000) reported hatching of delta smelt eggs after 8-10 days at temperatures between 15-17° C. Wang (2007) reported high hatching rates at temperatures between 14-17° C. At hatching and during the succeeding three days, larvae are buoyant, swim actively near the water surface, and do not react to bright direct light (Mager et al. 2004). As development continues, newly hatched delta smelt become semi-buoyant.

Analyses of otoliths indicate larval delta smelt grow to twice their size after 40 days (Bennett 2005), and by 70 days, most wild fish were 30-40 mm long and beyond the larval stage. This suggests there is a strong selective pressure for rapid larval growth in nature, a situation that is typical for fish in general (Houde 1987). Successful feeding seems to depend on a high density of food organisms and turbidity, and increases with stronger light conditions (Baskerville-Bridges et al. 2000; Mager et al. 2004; Baskerville-Bridges et al. 2004). The food available to larval smelt is constrained by mouth gape and status of fin development. Larval smelt cannot capture as many kinds of prey as larger individuals, but all life stages have small gapes that limit their range of potential prey. Prey availability is also constrained by habitat use, which affects what types of prey are encountered. Larval smelt are visual feeders and their ability to see prey in the water is enhanced by turbidity (Baskerville-Bridges et al. 2004). Thus, smelt diets are largely comprised of small crustacea that inhabit the estuary's turbid, low-salinity, open-water habitats (i.e., zooplankton). Larval smelt have particularly restricted diets (Nobriga 2002) and they do not feed on the full array of zooplankton with which they co-occur; they mainly consume three copepods, *Eurytemora affinis*, *Pseudodiaptomus forbesi*, and freshwater species of the family Cyclopidae. Further, the diets of first-feeding smelt larvae are largely restricted to the larval stages of these copepods; older, larger life stages of the copepods are increasingly targeted as the smelt larvae grow, their gape increases, and they become stronger swimmers.

The triggers for, and the duration of, delta smelt larval movement from spawning areas to rearing areas are not known. Most larvae gradually move downstream toward the two parts per thousand isohaline (X2), where X2 is scaled as the distance in kilometers from the Golden Gate Bridge (Jassby et al. 1995). Young-of-the-year smelt rear in the low-salinity zone (LSZ) from late spring through fall and early winter. Once in the rearing area growth is rapid, and juvenile fish are 40-50 mm sdl by early August (Erkkila et al. 1950; Ganssle 1966; Radtke 1966). They reach adult size (55-70 mm sdl) by early fall (Moyle 2002) and smelt growth slows considerably (only 3-9 mm total) during the fall months, presumably because most of the energy ingested is being directed towards gonadal development (Erkkila et al. 1950; Radtke 1966).

Population Dynamics and Abundance Trends- CDFW conducts several long-term monitoring surveys that have been used to index the relative abundance of smelt. The 20-mm Survey (CDFW 2014a) has been conducted every year since 1995 and samples April-June, targeting late-stage smelt larvae. The summer townet survey (TNS) has been conducted nearly every year between June-August, since 1959, and targets 38-mm striped bass, but collects similar-sized juvenile smelt. The FMWT has been conducted nearly every year since 1967, and like the TNS, the survey targets age-0 striped bass but collects smelt > 40 mm in length. The FMWT samples from September through December. The smelt catch data and relative abundance indices derived from these sampling programs have been used in numerous publications (e.g., Stevens and Miller 1983; Moyle et al. 1992; Jassby et al. 1995; Kimmerer 2002b; Dege and Brown 2004; Bennett 2005; Feyrer et al. 2007; Sommer et al. 2007; Kimmerer 2008; Newman 2008; Nobriga et al. 2008; Kimmerer et al. 2009; Mac Nally et al. 2010; Thomson et al. 2010; Feyrer et al. 2011; Maunder and Deriso 2011) and the abundance index time series documents the long-term decline of the smelt.

At all life stages, delta smelt are found in greatest abundance in the water column and usually not in close association with the shoreline. They inhabit open, surface waters of the Delta and Suisun Bay, where they presumably aggregate in loose schools where conditions are favorable (Moyle 2002). In years of moderate to high Delta outflow, delta smelt larvae are abundant in the Napa River, Suisun Bay and Montezuma Slough, but the degree to which these larvae are produced by locally spawning fish versus the degree to which they originate upstream and are transported by tidal currents to the bay and marsh is uncertain.

Sampling of larval delta smelt in 1989 and 1990 suggested that spawning occurred in the Sacramento River; in Georgiana, Prospect, Beaver, Hog, and Sycamore sloughs; in the San Joaquin River adjacent to Bradford Island and Fisherman's Cut; and possibly other areas (Wang 1991). However, in recent years, the densest concentrations of both spawners and larvae have been recorded in the Cache Slough/Sacramento Deepwater Ship Channel complex in the North Delta. Some delta smelt spawning occurs in the Napa River, Suisun Bay and Suisun Marsh during wetter years (Sweetnam 1999; Wang 1991; Hobbs et al. 2007). Early stage larval delta smelt have also been recorded in Montezuma Slough near Suisun Bay (Wang 1986).
The timing of spawning may affect delta smelt population dynamics. Lindberg (2011) has suggested that smelt larvae that hatch early, around late February, have an advantage over larvae hatched during late spawning in May. Early season larvae have a longer growing season and may be able to grow larger faster during more favorable habitat conditions in the late winter and early spring. An early growing season may result in higher survivorship and a stronger spawning capability for that generation. Larvae hatched later in the season have a shorter growing season which effectively reduces survivorship and spawning success for the following spawning season.

Early statistical assessments of delta smelt population dynamics concluded that at best, the relative abundance of the adult delta smelt population had only a very weak influence on subsequent juvenile abundance (Sweetnam and Stevens 1993). Thus, early attempts to describe abundance variation in delta smelt ignored stock-recruit effects and researchers looked for environmental variables that were directly correlated with interannual abundance variation (e.g., Stevens and Miller 1983; Moyle et al. 1992; Sweetnam and Stevens 1993; Herbold 1994; Jassby et al. 1995). Because delta smelt live in a habitat that varies in size and quality with Delta outflow, the authors cited above searched for a linkage between Delta outflow (or X2) and the TNS and FMWT indices. Generally, these analyses did not find strong support for an outflow-abundance linkage, which led to a prevailing conceptual model that multiple interacting factors had caused the delta smelt decline (Moyle et al. 1992; Bennett and Moyle 1996; Bennett 2005). It has also recently been noted that delta smelt's FMWT index is partly influenced by concurrent environmental conditions (Feyrer et al. 2007; 2011). This may be a partial explanation for why few analyses could consistently link springtime environmental conditions to delta smelt's fall index.

Delta smelt abundance plays an important role in subsequent abundance (Bennett 2005; Maunder and Deriso 2011). Bennett (2005) assessed data from CDFW's FMWT and TNS, and concluded that two-year-old delta smelt might play an important role in delta smelt population dynamics, that it was not clear whether juvenile production was a density-independent or -dependent function of adult abundance, and that adult production is a density-dependent function of juvenile abundance. He also concluded that the carrying capacity of the estuary to support this life-stage transition had declined over time. These conclusions are also supported by Maunder and Deriso (2011).

Delta smelt population dynamics may have also changed over time. Previous publications have reported a delta smelt step-decline during 1981-1982 (Kimmerer 2002b; Thomson et al. 2010). Prior to this decline, the stock-recruit data are consistent with "Ricker" type density-dependence where increasing adult abundance resulted in decreased juvenile abundance. Since the decline, recruitment has been positively and essentially linearly related to prior adult abundance, suggesting that reproduction has been basically density-independent for about the past 30 years. This means that since the early 1980s, more adults translates into more juveniles and fewer adults translates into fewer juveniles without being "compensated for" by density-dependence.

In contrast to the transition among generations, the weight of scientific evidence strongly supports the hypothesis that, at least over the history of Interagency Ecological Program fish monitoring, delta smelt has experienced density-dependence during the juvenile stage of its life cycle (Bennett 2005; Maunder and Deriso 2011). This has been inferred because, statistically, the FMWT index does not increase linearly with increases in the TNS index. Rather, the best-fitting relationships between the TNS index and the FMWT index show the FMWT indices approach an asymptote as the TNS indices increases, or possibly even declines at the highest TNS indices.

From a species conservation perspective, the most relevant aspect of this juvenile density dependence is that the carrying capacity of the estuary for delta smelt has declined (Bennett 2005). Thus, the delta smelt population decline has occurred for two basic reasons. First, the compensatory density-dependence that historically enabled juvenile abundance to rebound from low adult numbers stopped happening. The reason is still not known, but the consequence of the change is that for the past several decades, adult abundance drives juvenile production in a largely density-independent manner. Thus, if numbers of adults or adult fecundity decline, juvenile production will also decline (Kimmerer 2011). Second, because juvenile carrying capacity has declined, juvenile production hits a "ceiling" at a lower abundance than it once did. This limits adult abundance and possibly per capita fecundity, which cycles around and limits the abundance of the next generation of juveniles. The mechanism causing carrying capacity to decline is likely due to the long-term accumulation of deleterious habitat changes – both physical and biological – during the summer-fall (Bennett et al. 2008; Feyrer et al. 2007; 2011; Maunder and Deriso 2011).

Habitat

The existing physical appearance and hydrodynamics of the Delta have changed substantially from the environment in which native fish species like delta smelt evolved. The Delta once consisted of tidal marshes with networks of diffuse dendritic channels connected to floodplains of wetlands and upland areas (Moyle 2002). The in-Delta channels were further connected to drainages of larger and smaller rivers and creeks entering the Delta from the upland areas. In the absence of upstream reservoirs, freshwater inflow from smaller rivers and creeks and the Sacramento and San Joaquin Rivers were highly seasonal and more strongly and reliably affected by precipitation patterns than they are today. Consequently, variation in hydrology, salinity, turbidity, and other characteristics of the Delta aquatic ecosystem was greater in the past than it is today (Kimmerer 2002a). The following is a brief description of the changes that have occurred to delta smelt's habitat.

<u>Changes to the LSZ:</u> There have been documented changes to the delta smelt's LSZ habitat that have led to present-day habitat conditions. The close association of delta smelt with the San Francisco estuary LSZ has been known for many years (Stevens and Miller 1983; Moyle et al. 1992). Peterson (2003) developed a conceptual model that hypothesized how, "stationary and dynamic components of estuarine habitats" interacted to influence fisheries production in tidal river estuaries. Peterson's model suggests that when the dynamic and static aspects of estuarine habitat sufficiently overlap, foraging, growth, density, and survival are all high, and that enables fish production to outpace losses to predators. The result is high levels of successful recruitment of new individuals. The model also hypothesizes that when the dynamic and static aspects of an estuarine habitat do not sufficiently overlap, foraging, growth, density, and survival are impaired such that losses to predators increase and recruitment of new individuals decreases. This model was developed specifically for species spawned in marine environments that were subsequently transported into estuaries. However, the concept of X2, which was developed in the San Francisco estuary to describe how freshwater flow affected estuarine habitat (Jassby et al. 1995), played a role in the intellectual development of Peterson's model.

Current information indicates the most suitable delta smelt habitat is when low-salinity water is near 20°C, highly turbid, oxygen saturated, low in contaminants, supports high densities of calanoid copepods and mysid shrimp (Moyle et al. 1992; Lott 1998; Nobriga 2002), and occurs over comparatively static 'landscapes' that support sandy beaches and bathymetric variation that enables the fish and their prey to aggregate (Kimmerer et al. 2002a; Bennett et al. 2002; Hobbs et al. 2006). Almost every component listed above has been degraded over time and the Service has determined that this accumulation of habitat change is the fundamental reason or mechanism that has caused delta smelt to decline.

Alterations to estuarine bathymetry and salinity distribution- The position of the LSZ, where delta smelt rear, has changed over the years. The first major change in the LSZ was the conversion of the landscape over which tides oscillate and river flows vary (Moyle et al. 2010). Most of the historic wetlands within the system were diked and reclaimed for agriculture or other human uses by 1920 (Atwater et al. 1979) and channels were dredged to accommodate shipping traffic from the Pacific Ocean and San Francisco Bay to ports in Sacramento and Stockton. These changes left Suisun Bay and the confluence of the Sacramento-San Joaquin Rivers as the largest and most bathymetrically variable places in the LSZ. This region remained a highly productive nursery for many decades (Stevens and Miller 1983; Moyle et al. 1992; Jassby et al. 1995); however, the deepened channels required more freshwater outflow to maintain the LSZ in the large Suisun Bay and at the confluence than was once required (Gartrell 2010).

The construction of the Central Valley Water Project and the State Water Project not only provided water supply for urban, agricultural and industrial users, but also provided water needed to combat salinity intrusion into the Delta, which was observed by the early 20th century. California's demand for freshwater continues to increase and the seasonal salinity intrusion perpetually reduces the temporal overlap of the LSZ (indexed by X2) within the Suisun Bay, especially in the fall (Feyrer et al. 2007; 2011). Consequently, a major habitat change in the Delta has been in the frequency with which the LSZ is maintained in Suisun Bay for any given amount of precipitation. There was a step-decline in the LSZ in 1977 from which it has never recovered for more than a few years at a time. Based on model forecasts of climate change and water demand, this trend is expected to continue (Feyrer et al. 2011).

Summer and fall environmental quality has decreased overall in the Delta because outflows are lower and water transparency is higher. The confluence of the Sacramento and San Joaquin Rivers has, as a result, become increasingly important as a rearing location for delta smelt, with physical environmental conditions constricting the species range to a relatively narrow area (Feyrer et al. 2007; Nobriga et al. 2008). This has increased the likelihood that most of the juvenile population is exposed to chronic and cyclic environmental stressors, or catastrophic events. For instance, all seven delta smelt collected during the September 2007 fall mid-water trawl (FMWT) survey were captured at statistically significantly higher salinities than what will be expected based upon historical distribution data generated by Feyrer et al. (2007). During the same year, the annual bloom of toxic cyanobacteria (Microcystis aeruginosa) spread far downstream to the west Delta and beyond during the summer (Lehman et al. 2005), and this has been suggested as an explanation for the anomaly in the distribution of delta smelt relative to water salinity levels (USBR 2008).

Turbidity: From 1999 to present, the Delta experienced a change in estuarine turbidity that culminated in an estuary-wide step-decline in 1999 (Schoellhamer 2011). Since delta smelt associate with highly turbid waters, there is a negative correlation between the frequency of delta smelt occurrence in trawls during the summer, fall and early winter, at a given sampling station with increasing clarity, or Secchi depth (Feyrer et al. 2007, Nobriga et al. 2008). This is very consistent with behavioral observations of captive delta smelt (Nobriga and Herbold 2008). Few daylight trawls catch delta smelt at Secchi depths over 0.50 m and capture probabilities for delta smelt are highest at 0.40 m or less. Turbid waters are thought to increase foraging efficiency (Baskerville-Bridges et al. 2004) and reduce the risk of predation for delta smelt.

Temperature: Delta smelt of all sizes are found in the main channels of the Delta and Suisun Marsh and the open waters of Suisun Bay where the water is well oxygenated and temperatures are usually less than 25° C in summer (Nobriga et al. 2008). Swanson and Cech (1995) and Swanson et al. (2000) indicate delta smelt tolerate a range of temperatures (<8° C to >25° C), however warmer water temperatures >25° C restrict their distribution more than colder water temperatures (Nobriga and Herbold 2008). Currently, delta smelt are subjected to thermally stressful temperatures every summer, and all available regional climate change projections predict central California will be warmer still in the coming decades (Dettinger 2005). Water temperatures are presently above 20°C for most of the summer in core habitat areas, sometimes even exceeding the nominal lethal limit of 25°C for short periods. Coldwater fishes begin to have behavioral impairments (Marine and Cech 2004) and lose competitive abilities (Taniguchi et al. 1998) prior to reaching their thermal tolerance limits. Thus, the estuary can already be considered thermally stressful to delta smelt and can only become more so if temperatures warm in the coming decades.

Foraging Ecology: Delta smelt feed primarily on small planktonic crustaceans, and occasionally on insect larvae (Moyle 2002). Historically, the main prey of delta smelt was the euryhaline copepod *Eurytemora affinis* and the euryhaline mysid *Neomysis mercedis*. The slightly larger *Pseudodiaptomus forbesi* has replaced *E. affinis* as a major prey source of delta smelt since its introduction into the Bay-Delta (Moyle 2002). Another smaller copepod, *Limnoithona tetraspina*, was introduced to the Bay-Delta in the mid-1990s and is now one of the most abundant copepods in the LSZ, but not abundant in delta smelt diets. *Acartiella sinensis*, a calanoid copepod species that invaded the Delta at the same time as *L. tetraspina*, also occurs at high densities in Suisun Bay and in the western Delta over the last decade. Delta smelt eat these newer copepods, but Pseudodiaptomus remains their dominant prey (Baxter et al. 2008).

River flows influence estuarine salinity gradients and water residence times and thereby affect both habitat suitability for benthos and the transport of pelagic plankton upon which delta smelt feed. High tributary flow leads to lower residence time of water in the Delta, which generally results in lower plankton biomass (Kimmerer 2004). Higher residence times, which result from low tributary flows, can result in higher plankton biomass, but water diversions, overbite clam grazing (Jassby et al. 2002), and possibly contaminants (Baxter et al. 2008) remove a lot of plankton biomass when residence times are high. Delta smelt cannot occupy much of the Delta anymore during the summer (Nobriga et al. 2008) and there is a potential disconnect between regions of high zooplankton abundance in the Delta and delta smelt distribution.

<u>Aquatic Macrophytes</u>: For many decades, the Delta's waterways were turbid and growth of submerged plants was apparently unremarkable. That began to change in the mid-1980s, when the Delta was invaded by the non-native plant, *Egeria densa*, a fast-growing aquatic macrophyte that has now taken hold in many shallow habitats throughout the Delta (Brown and Michnuik 2007; Hestir 2010). The large canopies formed by *E. densa* and other non-native species of submerged aquatic vegetation (SAV) have physical and biological consequences for the ecosystem (Kimmerer et al. 2008) and delta smelt. First, the dense nature of SAV promotes sedimentation of particulate matter from the water column, which increases water transparency that then limits the amount of habitat available for delta smelt (Feyrer et al. 2007; Nobriga et al. 2008). Second, dense SAV canopies provide habitat for a suite of non-native fishes that occupy the Delta, displacing native fishes (Nobriga et al. 2005; Brown and Michniuk 2007) and increasing predation pressure on delta smelt. Third, the rise in SAV over the last three decades has led to a shift in the dominant trophic pathways that fuel fish production in the Delta. Until the latter 1980s, the food web of most fishes was often dominated by mysid shrimp (Feyrer et al. 2003) that were subsidized by phytoplankton food sources (Rast and Sutton 1989). Most littoral and demeral fishes of the Delta have diets dominated by the epibenthic amphipods that eat SAV detritus or the epiphytic algae attached to SAV (Grimaldo et al. 2009). Lastly, SAV can overwhelm littoral habitats (inter-tidal shoals and beaches) where delta smelt may spawn making them unsuitable for spawning.

<u>Predators</u>: Nothing is known about the historic predators of delta smelt or their possible influence on delta smelt population dynamics. Fish eggs and larvae can be opportunistically preyed upon by many invertebrate and vertebrate animals. The eggs and newly-hatched larvae of delta smelt are thought to be prey for Mississippi silversides (Bennett 2005), and potentially yellowfin goby, centrarchids, and Chinook salmon. Centrarchid fishes and Chinook salmon smolts released in the Delta for research may prey on larval delta smelt (Brandes and McLain 2001; Nobriga and Chotkowski 2000) and studies during the early 1960s found delta smelt were an occasional, but rare, prey fish for striped bass, black crappie and white catfish (Turner and Kelley 1966). Since delta smelt were a comparatively rare fish historically, it is not surprising that they were also a rare prey item.

The introduction of striped bass into the San Francisco Estuary in 1879 added a permanently resident, large piscivorous fish to the LSZ. The LSZ is a habitat not known to have had an equivalent predator prior to the establishment of striped bass (Moyle 2002). The current influence of striped bass and other predators on delta smelt population dynamics is unknown, mainly because predator effects on rare prey are extremely difficult to quantify. Delta smelt were observed in the stomach contents of striped bass and other fishes in the 1960s (Stevens 1963; Turner and Kelley 1966), but have not been in more recent studies (Feyrer et al. 2003; Nobriga and Feyrer 2007).

Potential native predators of juvenile and adult delta smelt will have included numerous bird and fish species, which may be reflected in delta smelt's life-history. Annual fish species, also known as "opportunistic strategists", are adapted to high mortality rates in the adult stage (Winemiller and Rose 1992). This high mortality is usually due to predation or highly unpredictable environmental conditions, both of which could have characterized the ancestral niche of delta smelt.

Predation is a common source of density-dependent mortality in fish populations (Rose et al. 2001), thus, it is possible that predation was a mechanism that historically generated the density-dependence observation in delta smelt population dynamics that has been noted by Bennett (2005) and Maunder and Deriso (2011). As is the case with other fishes, the vulnerability of delta smelt to predators may be influenced primarily by habitat suitability. It is widely documented that pelagic fishes, including many smelt species, experience lower predation risks under turbid water conditions (Thetmeyer and Kils 1995; Utne-Palm and Stiansen 2005; Horpilla et al. 2004,). Growth rates, a result of feeding success plus water temperature, are also well known to affect fishes' cumulative vulnerability to predation (Sogard 1997).

Competition: It has been hypothesized that delta smelt are adversely affected by competition from other introduced fish species that use overlapping habitats, including Mississippi silversides, (Bennett and Moyle 1996) striped bass, and wakasagi (Sweetnam 1999). Laboratory studies show that delta smelt growth is inhibited when reared with Mississippi silversides (Bennett 2005) but there is no empirical evidence in the wild to support this conclusion.

The LSZ historically had the highest primary productivity and is where zooplankton populations were historically most dense (Knutson and Orsi 1983; Orsi and Mecum 1996). However, since the introduction of the overbite clam, this has not always been true (Kimmerer and Orsi 1996). There is some speculation that the overbite clam competes with delta smelt for copepod nauplii (Nobriga and Herbold 2008) but it is unknown how intensively overbite clam grazing and delta smelt directly compete for food.

Contaminants: Contaminants can change ecosystem functions and productivity through numerous pathways. However, contaminant loading and its ecosystem effects within the Delta are not well understood. Although a number of contaminant issues were first investigated during the Pelagic Organism Decline (POD) years, concern over contaminants in the Delta is not new. Current science suggests the possible link between contaminants and the POD may be the effects of contaminant exposure on prey items, resulting in an indirect effect on the survival of POD species (Johnson et al. 2010). Pyrethroids are of particular interest because use of these pesticides has increased within the Delta watershed (Amweg et al. 2005, Oros and Werner 2005). Urban source waters with pyrethroid pesticides have shown toxicity to the amphipod *Hyalella azteca*, and high mortality rates and swimming impairment in fishes (Weston and Lydy 2010).

The association of delta smelt spawning with turbid winter runoff and the association of pesticides including pyrethroids with sediment is of potential concern. Persistent confinement of the spawning population of delta smelt to the Sacramento River increases the likelihood that a substantial portion of the spawners will be affected by a catastrophic event or localized chronic threat. For instance, large volumes of highly concentrated ammonia released into the Sacramento River from the Sacramento Regional County Sanitation District may affect embryo survival or inhibit prey production. Further, agricultural fields in the Yolo Bypass and surrounding areas are regularly sprayed by pesticides, and water samples taken from Cache Slough sometimes exhibited toxicity to *H. azteca* (Werner et al. 2008; 2010). The extent to which delta smelt larvae are exposed to contaminants varies with flow entering the Delta, where flow pulses during spawning increase exposure to many pesticides (Kuivila and Moon 2004) but decrease ammonia concentrations from wastewater treatment plants. The thresholds of toxicity for delta smelt for most of the known contaminants have not been determined, but the exposure to a combination of different compounds increases the likelihood of adverse effects.

Delta Smelt Critical Habitat

The Service designated critical habitat for the delta smelt on December 19, 1994 (Service 1994). The geographic area encompassed by the designation includes all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the existing contiguous waters contained within the legal Delta (as defined in section 12220 of the California Water Code). Critical habitat is defined in section 3 of the Act as: (1) the specific areas within the geographical area occupied by a species, at the time it is listed in accordance with the Act, on which are found those physical or biological features (a) essential to the conservation of the species and (b) that may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by a species at the time it is listed, upon determination that such areas are essential for the conservation of the species. In determining which areas to designate as critical habitat, the Service considers those physical and biological features that are essential to a species' conservation and that may require special management considerations or protection (50 CFR 424.12(b)). The Service is required to list the known PCEs together with the critical habitat description. Such physical and biological features include, but are not limited to, the following:

1. Space for individual and population growth, and for normal behavior;
2. Food, water, air, light, minerals, or other nutritional or physiological requirements;
3. Cover or shelter;
4. Sites for breeding, reproduction, rearing of offspring, or dispersal; and
5. Generally, habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

The PCEs defined for the delta smelt were derived from its biological needs. In designating critical habitat for the delta smelt, the Service identified the following primary constituent elements essential to the conservation of the species: physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration. Specific areas that have been identified as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore sloughs and the Sacramento River in the Delta, and tributaries of northern Suisun Bay.

1. Physical habitat is defined as the structural components of habitat. Because delta smelt is a pelagic fish, spawning substrate is the only known important structural component of habitat. It is possible that depth variation is an important structural characteristic of pelagic habitat that helps fish maintain position within the estuary's LSZ (Bennett et al. 2002, Hobbs et al. 2006).

2. Water is defined as water of suitable quality to support various delta smelt life stages with the abiotic elements that allow for survival and reproduction. Delta smelt inhabit open

waters of the Delta and Suisun Bay. Certain conditions of temperature, turbidity, and food availability characterize suitable pelagic habitat for delta smelt and are discussed in detail in the Status of the Species section above. Factors such as high entrainment risk and contaminant exposure can degrade this PCE even when the basic water quality is consistent with suitable habitat.

3. River flow is defined as transport flow to facilitate spawning migrations and transport of offspring to LSZ rearing habitats. River flow includes both inflow to and outflow from the Delta, both of which influence the movement of migrating adult, larval, and juvenile delta smelt. Inflow, outflow, and Old and Middle Rivers flow influence the vulnerability of delta smelt larvae, juveniles, and adults to entrainment at Banks and Jones. River flow interacts with the fourth PCE, salinity, by influencing the extent and location of the highly productive LSZ where delta smelt rear.

4. Salinity is defined as the LSZ nursery habitat. The LSZ is where freshwater transitions into brackish water; the LSZ is defined as 0.5-6.0 parts per thousand salinity (psu) (Kimmerer 2004). The 2 psu X2 is a specific point within the LSZ where the average daily salinity at the bottom of the water is 2 psu (Jassby et al. 1995). By local convention the location of the LSZ is described in terms of the distance from the 2 psu X2 to the Golden Gate Bridge; X2 is an indicator of habitat suitability for many San Francisco Estuary organisms and is associated with variance in abundance of diverse components of the ecosystem (Jassby et al. 1995, Kimmerer 2002b). The LSZ expands and moves downstream when river flows into the estuary are high. Similarly, it contracts and moves upstream when river flows are low. During the past 40 years, monthly average X2 has varied from San Pablo Bay (45 kilometers) to as far upstream as Rio Vista on the Sacramento River (95 kilometers). At all times of year, the location of X2 influences both the area and quality of habitat available for delta smelt to successfully complete their life cycle. In general, delta smelt habitat quality and surface area are greater when X2 is located in Suisun Bay. Both habitat quality and quantity diminish as the LSZ moves more frequently and further upstream, toward the confluence.

Environmental Baseline

Delta smelt critical habitat extends along the Sacramento River to the I Street Bridge, and marks the eastern boundary of both basins of the West Sacramento Project. Delta smelt critical habitat also includes the Sacramento River Deep Water Ship Channel, which extends along the western boundary of the West Sacramento GRR Project South Basin and separates the North and South Basins at the Port of Sacramento.

Monitoring surveys along the Sacramento River adjacent to project construction areas have confirmed the presence of the smelt in trawl surveys (Service 2014b) and shallow water seine net surveys (Service 2014c). Trawl surveys conducted in March and April from Sherwood Harbor at River Mile 55, adjacent to the Sacramento River South levee, have recorded 51 smelt (Service 2012b). Similarly, one smelt was identified in a seine net survey at Sherwood Harbor in 2014, and over 50 smelt were netted between river miles 43 and 49, just downstream of the project South Basin, between 2012 and 2014 (Service 2014c). The surveys were conducted between November and April of successive years. The seine net surveys also noted 7 records of smelt adjacent to the project North Basin in February and March 2014, between river miles 60 and 62 (Service 2014c).

The Sacramento River Deep Water Ship Channel also provides suitable spawning habitat for the smelt (CDFW 2014c). At survey station 719, about 12 miles downstream of the South Cross Levee in the Sacramento Deep Water Ship Channel, March, 2014, 20mm surveys noted 48.84 smelt per

10,000 cubic meters, which is the highest catch rate of smelt in the Delta at that period. SKT trawl surveys during March and April of the past 3 years also showed the highest catch rates in the Delta (CDFW 2014a), demonstrating the importance of the Sacramento River Deep Water Ship Channel as a smelt spawning ground. In dry years, river flows can be expected to be relatively low, and hence the LSZ nursery habitat would move much further upstream, toward the project construction area.

Effects of the Proposed Action

Giant Garter Snake

Construction activities of the West Sacramento GRR Project, such as fill removal, grading, fill placement, wall construction, and vehicle movement will permanently degrade 23.24 acres of snake habitat, and results in temporary effects to 201 acres (Table 5). Permanent effects include the direct loss of snake habitat, while temporary effects result from seasonal construction activities that will be restored upon completion of the construction activities at each levee reach. The breakout for specific effects due to the Southport Project portion of the West Sacramento GRR Project are noted in Appendix B.

Table 5. Effects on giant garter snake (*Thamnophis gigas*) habitat in the West Sacramento General Reevaluation Report Project, West Sacramento, Yolo County, California.

Habitat	Temporary Effects	Permanent Effects
Aquatic Habitat	2	21
Upland Habitat	199[1]	2.24

[1] **The estimate is based on a worst-case scenario when considering necessary borrow material.**

The Corps has proposed to keep temporary effects to within one season (May 1 to October 1) which will minimize the temporal effects to the giant garter snake. Upon completion of temporary disturbance to habitat the Corps and WSAFCA will return the disturbed area to pre-project conditions. The Corps has proposed to compensate for the permanent loss of snake habitat through the purchase of 69.72 snake credits from a Service-approved conservation bank.

Habitat affected by the snake includes rice fields, which offer many similarities to the historical, natural wetlands of the area around the City of West Sacramento. Open agricultural fields within the action area of the West Sacramento GRR Project are largely fallow or planted in wheat. These fields are not irrigated with standing water in a manner that mimics the natural wetlands used by the giant garter snake. Although the drainage canals offer little in terms of prey base and vegetative cover, the drains lining the agricultural fields can provide avenues for snake travel.

Valley Elderberry Longhorn Beetle

As an Early Implementation Project, the Southport Project area along the South Sacramento River Levee was surveyed for elderberry shrubs 2011-2013. Surveys identified 41 shrubs containing 424 stems within the action area (Appendix B). An estimate of 18 shrubs (including 4 on inaccessible private lands) will be directly affected by construction activities, and will be removed and transplanted to the project offset floodplain area riparian zone if possible.

Transplanting the elderberry shrubs may cause them to die, become stressed, or become unhealthy due to transplanting. This may reduce the shrub's quality as habitat for the beetle, or impair production of habitat-quality stems in the future. Branches containing larvae may be cut, broken, or crushed during the transplantation process. These effects to the shrubs may cause the beetle to be harmed, harassed, injured, or killed.

The remaining 23 elderberry shrubs within 100 feet of construction activities will be protected during construction activities by implementing the listed Conservation Measures for the beetle. These measures will reduce the likelihood that the health and survival of the elderberry shrubs would be adversely affected by project activities to the point that take of the beetle is not reasonably likely to occur.

For the West Sacramento GRR Project as a whole, shrub counts were extrapolated to provide reasonable effects estimates for the complete project (Table 6). An estimated 215 elderberry shrubs will be affected by the West Sacramento GRR Project. To provide a worst-case scenario for analyses, all shrubs are assumed to be in riparian habitat and with evidence of beetle presence (holes in stems). Based on the results of these analyses, 118.42 acres will be required for elderberry and associated native species compensation plantings (Service 1999a). As part of the proposed conservation measures, the Corps is planning to use at least 13.51 acres of the Southport Project offset area riparian zone as an area for elderberry compensation plantings for the Southport Project portion of the West Sacramento GRR Project. The suitability of the offset area riparian zone for additional compensation will be dependent on site-specific conditions; additional compensation for the beetle will be acquired offsite.

Delta Smelt and Delta Smelt Critical Habitat

Potential spawning habitat includes shallow channel edge waters of the Sacramento River and Sacramento River Deep Water Ship Channel. Potential construction-related effects to smelt physical

Table 6. Estimates of elderberry shrubs affected by the West Sacramento General Reevaluation Report Project, West Sacramento, Yolo County, California.[1]

Location	Stem Diameter	Holes	Number of Stems	Elderberry Ratios	Elderberry Plantings	Associate Ratios	Associate Plantings
Riparian	≥ 1 inch and ≤ 3 inches	Yes	1,524	4:1	5,588	2:1	10,580
Riparian	> 3 inches and < 5 inches	Yes	391	6:1	2,160	2:1	4,032
Riparian	≥ 5 inches	Yes	303	8:1	2,237	2:1	4,109
Totals[2]			2,218		9,985		18,721

[1] Information based on the Conservation Guidelines for the Valley Elderberry Longhorn Beetle (Service 1999a).

[2] Southport Project effects are included.

habitat would include disruption of spawning activities, disturbance or mortality of eggs and newly hatched larvae, alteration of spawning and incubation habitat, and loss of shallow water habitat for spawning. The Corps has estimated that 13.35 acres of shallow water habitat that may be used for spawning or dispersal will be permanently lost through the completion of the West Sacramento GRR Project. In contrast, 118.81 acres of suitable delta smelt shallow water habitat will be created by the project in the Southport Project offset area, for a net gain of 105.46 acres of shallow water habitat. The floodplain is designed to contain water during months (December – May) when smelt larva are most likely to be present.

The West Sacramento GRR Project could detrimentally affect delta smelt by increasing turbidity, increasing noise, reducing water quality, creating predator habitat, restricting channels, and changing water velocities. Re-suspended sediments may contain toxic substances which may interfere with the development of young delta smelt. The substrate upon which delta smelt may depend for egg attachment and refugia may become silted over or removed by the proposed actions. As shallow water habitat is removed and turbidity increased, the delta smelt's feeding, breeding, and sheltering would likely be reduced as food sources associated with the aquatic plants and found in the water column is destroyed, and habitat used for spawning substrate and refugia is eliminated.

Rock slope protection can limit the lateral mobility of a river channel, increase flow velocities (Sedell et al.1990), limit sediment transport, and thus eliminate bankside refugia areas (Gregory et al. 1991). In turn, many of the streamside effects of increased velocity are transferred downstream (Larsen and Greco 2002). Although work along the Sacramento River includes additional rock slope protection, the negative effects to shallow water habitat, both at the project construction areas and downstream along the Sacramento River, are expected to be offset by the creation of the riparian and floodplain area of the Southport Project. The offset floodplain area is designed to absorb much of the increased flow energy, instead of having it transferred downstream. The floodplain area is expected to provide more space for population growth, additional cover or shelter, and additional habitat that is, for the most part, protected from large fluctuations in river velocities.

Adult delta smelt migrate upstream between December and January and spawn between January and July, with a peak in spawning activity between April and mid-May (Moyle 2002). The above effects are reduced by the restriction of project in-water work to time periods when delta smelt eggs, larvae, and juveniles are not present and delta smelt adults are rarely present or present in low numbers, between August 1 and November 30. In addition, the above effects are further greatly reduced by the creation of suitable shallow water habitat in the Southport Project offset floodplain area.

However, the creation of the Southport Project offset floodplain area could introduce increased predation and competition from exotic species. Fishes introduced to the Sacramento-San Joaquin Delta, such as the largemouth bass (*Micropterus salmoides*) and smallmouth bass (*M. dolomieu*), thrive as predators in warm, shallow water habitat. Such introduced fish may increase predation pressure upon the delta smelt in newly designed shallow water habitat. Reduced feeding efficiency and ingestion rates due to introduced competition into the designed smelt habitat, such as from the wagasaki (*Hypomesus nipponensis*), could weaken and slow the growth of young delta smelt and make them more vulnerable to starvation and predation.

Cumulative Effects

Cumulative effects are those effects of future State, Tribal, county, local agency, and private actions that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the Act.

The California Department of Finance (2013) has projected the population within Sacramento County to rise 65% from 2010 levels to 2060, while Yolo County similarly is expected to experience nearly 66% growth over the same period. The West Sacramento GRR Project will afford increased flood protection for a growing community, which in turn could increase human-based pressures incrementally on the federally-listed species. For example, drainage areas that may now be used by snakes as travel corridors may cease to be useful for snakes with the onset of increased human activity in close proximity to waterways with no appropriate snake cover. Also, project effects to the snake, beetle, and smelt are expected to extend for several years as project construction progresses sequentially over time. To minimize unavoidable effects to the federally-listed species, the Corps has proposed several compensatory measures that will be implemented and maintained in perpetuity.

Cumulative effects on the delta smelt and its designated critical habitat include the effects of point and non-point source chemical contaminant discharges. These contaminants include numerous pesticides and herbicides associated with discharges related to agricultural and urban activities. Implicated as potential sources of mortality for delta smelt, these contaminants may adversely affect delta smelt reproductive success and survival rates. Spawning habitat may also be affected if submersed aquatic plants used as substrates for adhesive egg attachment are lost due to toxic substances.

Additional cumulative effects may result from diversions of water that may entrain adult or larval fish or that may change outflows incrementally, either excluding delta smelt from Sacramento River flow or shifting the position of the delta smelt from its preferred habitat.

Conclusion

After reviewing the current status of the snake, beetle, smelt, and smelt critical habitat, the environmental baseline for the action area covered in this biological opinion, the effects of the proposed project, the cumulative effects, and the proposed conservation measures, it is the Service's biological opinion that the West Sacramento GRR Project, as proposed, is not likely to jeopardize the continued existence of these species. Also, the project will not result in net destruction or adverse modification of smelt critical habitat. The Service reached this conclusion because the anticipated level of take of the snake, beetle, and smelt, upon analyses of project effects in relation the environmental baseline for these species, will not rise to levels precluding the recovery of these species, or reduce the likelihood of survival of these species.

The West Sacramento GRR Project will contribute to the conservation of the snake by preserving suitable snake habitat at a conservation bank. Also, the description of the West Sacramento GRR Project contains the Southport Project, which includes the creation of an offset floodplain area that will provide riparian habitat with space for transplanting elderberry shrubs displaced by the project. Any additional offsite areas necessary for elderberry compensation will be protected in perpetuity. In addition, the offset floodplain area will provide a net gain in the amount of suitable smelt shallow water habitat during the spring months, when the area is most likely to be used by the smelt for feeding and reproduction.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service regulations at 50 CFR 17.3 as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the same regulations as an act which actually kills or injures wildlife. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

Amount or Extent of Take

The Service anticipates incidental take of giant garter snakes will occur in the form of disturbance, harm, and harassment. Incidental take also may occur in the form of injury or death to snakes occupying levee holes or crevices unseen during construction. Within the West Sacramento GRR Project action area, effects to snakes at individual levee reaches will vary. Giant garter snakes are secretive and sensitive to human activities. Individual snakes are difficult to detect unless they are observed, undisturbed, at a distance. Most close-range observations represent chance encounters that are difficult to predict. In instances in which the total number of individuals anticipated to be taken cannot be determined, the Service may use the amount of habitat impacted as a surrogate; because the take of individuals anticipated will result from the destruction of the snake habitat, the quantification of suitable habitat serves as a direct surrogate for the snakes that will be lost. Over the course of project construction, the Service anticipates that all giant garter snakes found in 241 acres of habitat will be disturbed, harassed, harmed, or killed by project activities resulting in temporary impacts and permanent impacts, especially from dewatering, channel reconfiguration, and use of heavy equipment within or near aquatic habitat. Thirty acres of giant garter snake habitat may be permanently lost over the course of project construction.

Implementation of the West Sacramento GRR Project will result in the incidental take of the beetle resulting from project impacts to 215 elderberry shrubs with 2,218 stems one inch or greater in diameter at ground level. The life stage affected by this action will be the beetle larvae living within the stems of the elderberry shrubs. The life cycle of the beetle takes 1 or 2 years to complete, during which it spends most of its life in the larval stage. It is not possible to know how many beetle larvae are in the stems of any elderberry shrub, therefore the Service cannot quantify the total number of beetles that we anticipate will be taken as a result of the proposed action. Because the take of individuals anticipated will result from the destruction of the elderberry shrubs, the quantification of suitable habitat serves as a direct surrogate for the beetles that will be lost. Therefore, the Service anticipates take incidental to this project as the 215 elderberry shrubs with 2,218 stems one inch or greater in diameter at ground level that could potentially be destroyed.

The Service anticipates that incidental take of delta smelt will occur. However, the Service anticipates that any take of delta smelt will be difficult to detect and quantify for a number of reasons: they have a relatively small body size; they are relatively secretive; their presence in the Delta and associated areas coincides with relatively turbid conditions, which makes their detection difficult. Therefore, it is not possible to provide precise numbers of delta smelt that could be injured, harassed, harmed, or killed from the project. The Service anticipates that all delta smelt inhabiting up to 13.35 acres of shallow water habitat may be harmed, harassed, injured, or killed as a result of the project. Low mortality is anticipated because of the work restriction windows. Because the species is wide-ranging and its distribution varies from one year to the next, take may vary from year to year over the 19-year construction period. Additionally, losses of the species may be masked by seasonal fluctuations in fish presence. Upon implementation of the following reasonable and prudent measure, incidental take associated with the project in the form of harm, harassment, injury, or mortality to delta smelt, the Corps will become exempt from the prohibitions described under section 9 of the Act.

Effect of the Take

The Service has determined that this level of anticipated take is not likely to result in jeopardy to the snake, beetle, or smelt. Also, the West Sacramento GRR Project will not result in the destruction or adverse modification of designated critical habitat for the delta smelt.

Reasonable and Prudent Measure

The Service has determined that the following reasonable and prudent measure is necessary and appropriate to minimize the effects of the proposed project on the snake, beetle, and smelt:

1. All conservation measures proposed in the biological assessment, and as re-stated in the project description section of this biological opinion, must be fully implemented and adhered to. Further, this Reasonable and Prudent Measure shall be supplemented by the Terms and Conditions listed below.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measure described above. These terms and conditions are nondiscretionary.

1. The Service shall be informed of any changes in project construction scheduling as soon as possible. Should the project schedule be altered from that described herein, the Corps must immediately reinitiate formal consultation as per 50 §CFR 402.16.

2. The Corps shall comply with the latest Conservation Guidelines for the Valley Elderberry Longhorn Beetle (Service 1999a). The Corps shall check with the Service before each construction season to ensure that any and all updates to these guidelines are incorporated into the project. The Service shall be informed of conservation area monitoring plans to ensure that success criteria outlined in these guidelines are accurately assessed.

3. To monitor whether the amount or extent of incidental take anticipated from implementation of the proposed project is approached or exceeded, the Corps shall adhere to the following reporting requirement. Should this anticipated amount or extent of incidental take be exceeded, the Corps must immediately reinitiate formal consultation as per 50 §CFR 402.16.

    a. For those components of the action that will result in habitat degradation or modification whereby incidental take in the form of harm is anticipated, the Corps will provide monthly updates to the Service with a precise accounting of the total acreage of habitat impacted. Updates shall also include any information about proposed changes in project implementation that result in habitat disturbance not described in the Project Description and not analyzed in this biological opinion.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities that can be implemented to further the purposes of the Act, such as preservation of endangered species habitat, implementation of recovery actions, or development of information or data bases. The Service is providing the following conservation recommendations:

1. The Corps should communicate with the Service to ensure that the most up to date plans for the recovery of each federally-listed species are recognized and followed:

    a. The Corps should work with the Service to assist us in meeting the goals of the latest Recovery Plan for the valley elderberry longhorn beetle, which currently is the Valley Elderberry Longhorn Beetle Recovery Plan (Service 1984);

    b. The Corps should work with the Service to assist us in meeting the goals of the latest Recovery Plan for the giant garter snake, which currently is the 1999 Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*) (Service 1999b); and

    c. The Corps should work with the Service to assist us in meeting the goals of the latest Recovery Plan for the delta smelt, which currently is the 1996 Recovery Plan for the Sacramento-San Joaquin Delta Native Fishes (Service 1996).

2. The Corps and WSAFCA should monitor the effectiveness of the offset floodplain area in providing spawning and rearing habitat, as well the effectiveness of the floodplain in providing juvenile and adult transport and migration

So the Service can be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendation.

REINITIATION - CLOSING STATEMENT

This concludes formal consultation on the West Sacramento Project General Reevaluation Report Project in Yolo County, California. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and: (a) if the amount or extent of taking specified in the incidental take statement is exceeded; (b) if new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (c) if the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; or (d) if a new species is listed or critical habitat designated that may be affected by the identified action.

If you have questions regarding the West Sacramento West Sacramento GRR Project, please contact Jennifer Hobbs (Jennifer_hobbs@fws.gov), Fish and Wildlife Biologist at (916)414-6541, or Doug Weinrich (douglas_weinrich@fws.gov), Assistant Field Supervisor.

Sincerely,

Doug Weinrich

for Jennifer M. Norris
Field Supervisor

Enclosure:

cc:
Sarah Ross Arrouzet, Corps of Engineers, Sacramento, California
Maria Rae, National Marine Fisheries Service, Sacramento, California
Howard Brown, National Marine Fisheries Service, Sacramento, California
John Powderly, City of West Sacramento, West Sacramento, California

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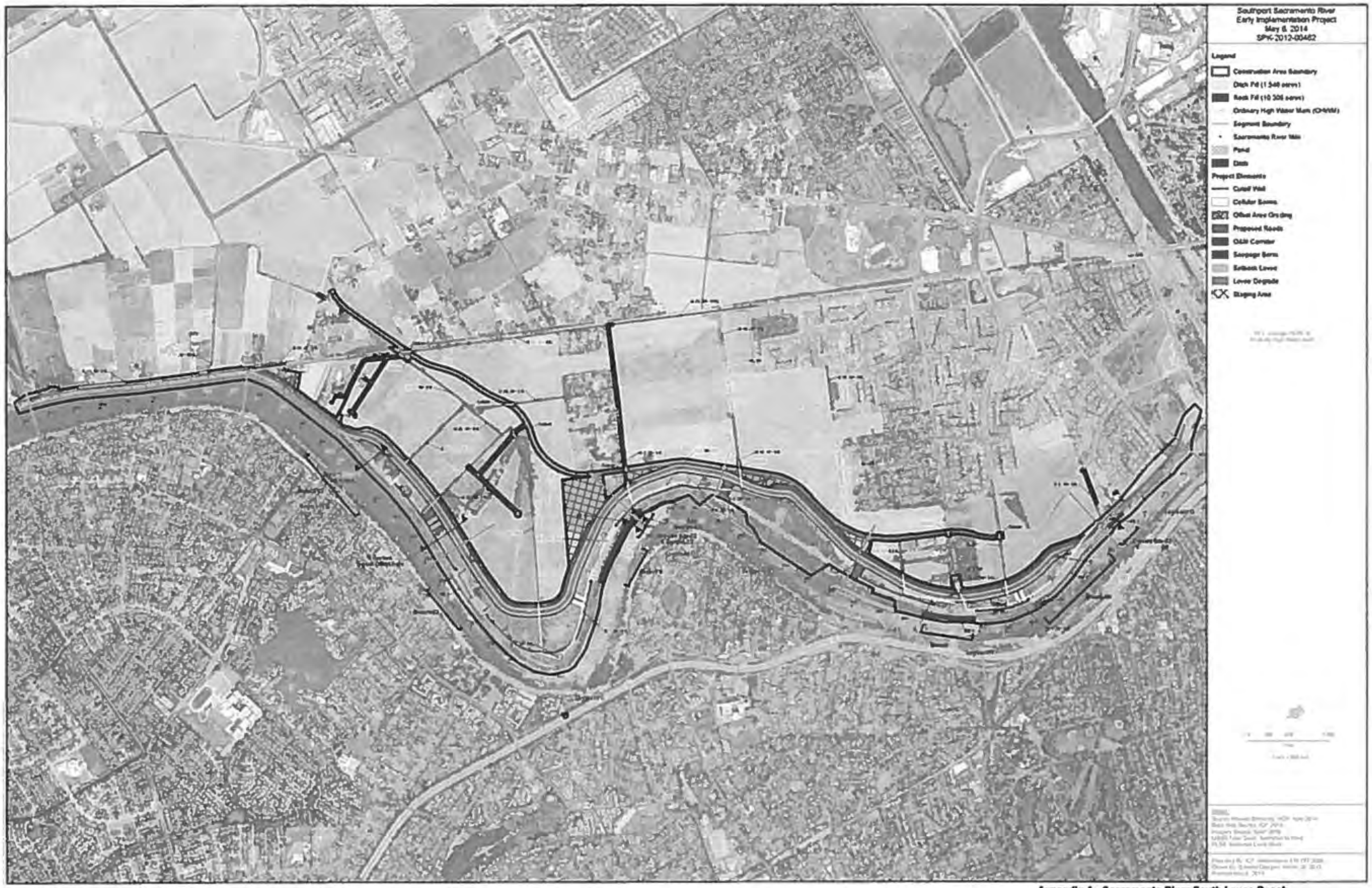
APPENDIX A

SOUTHPORT EARLY IMPLEMENTATION PROJECT

Project Plan View



Appendix A. Sacramento River South Levee Reach
Southport Early Implementation Project
West Sacramento General Reevaluation Report

APPENDIX B

SOUTHPORT EARLY IMPLEMENTATION PROJECT

Project Effects on Federally-Listed Species Within U.S. Fish and Wildlife Service Jurisdiction

Table B-1. Effects on giant garter snake (*Thamnophis gigas*) in the Southport Early Implementation Project action area of the West Sacramento General Reevaluation Report Project, West Sacramento, Yolo County, California.

Habitat	Temporary Effects	Permanent Effects
Aquatic Habitat	0	0
Upland Habitat	155	2.24

Table B-2. Estimates of elderberry shrubs affected by the Southport Project Early Implementation Project of the West Sacramento General Reevaluation Report Project, West Sacramento, Yolo County, California.[1]

Location	Stem Diameter	Holes	Number of Stems	Elderberry Ratios	Elderberry Plantings	Associate Ratios	Associate Plantings
Non-riparian	≥ 1 inch and ≤ 3 inches	No	6	1:1	6	1:1	6
		Yes	135	2:1	270	2:1	540
Non-riparian	> 3 inches and < 5 inches	No	1	2:1	2	1:1	2
		Yes	22	4:1	88	2:1	176
Non-riparian	≥ 5 inches	No	1	3:1	3	1:1	3
		Yes	37	6:1	222	2:1	444
Riparian	≥ 1 inch and ≤ 3 inches	No	110	2:1	220	1:1	220
		Yes	25	4:1	100	2:1	200
Riparian	> 3 inches and < 5 inches	No	46	8:1	138	1:1	138
		Yes	10	6:1	60	2:1	120
Riparian	≥ 5 inches	No	27	4:1	108	1:1	108
		Yes	4	8:1	32	2:1	64
Totals			424		1,249[2]		2,021[2]

[1] Information based on the Conservation Guidelines for the Valley Elderberry Longhorn Beetle (Service 1999a).
[2] Plantings require 588,600 square feet or 13.51 acres.

Table B-3. Effects on delta smelt (*Hypomesus transpacificus*) critical habitat in the Southport Early Implementation Project action area of the West Sacramento General Reevaluation Report Project, West Sacramento, Yolo County, California.

Shallow Water Habitat Created	Shallow Water Habitat Affected
118.81 acres	8.49 acres (0.04 permanently)

West Sacramento GRR EIS/EIR
Appendix J

Final Biological Opinions
Enclosure 2

NMFS Biological Opinion

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

SEP 8 2015 Refer to NMFS No: WCR-2014-1375

Ms. Alicia Kirchner
Acting Regional Resources Manager
Department of the Army
United States Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, California 95814-2922

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response, for the West Sacramento General Reevaluation Study (West Sacramento GRS)

Dear Ms. Kirchner:

Thank you for your letter of November 24, 2014, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the West Sacramento GRS.

This letter also transmits NMFS's essential fish habitat (EFH) conservation recommendations for Pacific salmon as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA) as amended (16 U.S.C. 1801 *et seq*.).

Based on the best available scientific and commercial information, the Biological Opinion (BO) concludes that the West Sacramento GRS is not likely to jeopardize the continued existence of the federally listed threatened Central Valley (CV) spring-run Chinook salmon evolutionarily significant unit (ESU) (*Oncorhynchus tshawytscha*), endangered Sacramento River winter-run Chinook salmon ESU (*O. tshawytscha*), or threatened California CV steelhead distinct population segment (DPS) (*O. mykiss*) or the threatened Southern DPS (sDPS) of North American green sturgeon (*Acipenser medirostris*), and is not likely to destroy or adversely modify their designated critical habitats. For the above species, NMFS has included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take of listed species associated with the project.

The EFH consultation concludes that the proposed action would adversely affect the EFH of Pacific salmon in the action area. The EFH consultation adopts the ESA reasonable and prudent measures and associated terms and conditions from the BO and includes additional conservation recommendations specific to the adverse effects to fall- and late fall-run Chinook salmon (*O. tshawytscha*) EFH.

The U.S. Army Corps of Engineers (Corps) has a statutory requirement under section 305(b)(4)(B) of the MSA to submit a detailed written response to NMFS within 30 days of receipt of these conservation recommendations, and 10 days in advance of any action, that includes a description of measures adopted by the Corps for avoiding, minimizing, or mitigating the impact of the project on EFH (50 CFR 600.920(j)). If unable to complete a final response within 30 days, the Corps should provide an interim written response within 30 days before submitting its final response. In the case of a response that is inconsistent with our recommendations, the Corps must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the West Sacramento GRS and the measures needed to avoid, minimize, or mitigate (also referred to as compensate by NMFS) such effects.

Please contact Howard Brown at the NMFS California Central Valley Office, 916-930-3608, or at Howard.Brown@noaa.gov, if you have any questions concerning this section 7 consultation, or if you require additional information.

Sincerely,

Maria Rea

fur William W. Stelle, Jr.
Regional Administrator

Enclosure

CC: File ARN 151422WCR214SA00214

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation.

West Sacramento GRS
NMFS Consultation Number: 2014-SA00214

Action Agency: U.S. Army Corps of Engineers (Corps)

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?*	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
CV spring-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No
Sacramento River winter-run Chinook salmon ESU (*O. tshawytscha*)	Endangered	Yes	No	No
California CV steelhead DPS (*O. mykiss*)	Threatened	Yes	No	No
Southern DPS of North American green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	No

Fishery Management Plan That Describes EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By: Maria Rea

for ~~William~~ W. Stelle, Jr.
Regional Administrator

Date: 1/8/15

List of Acronyms

BA	Biological Assessment
BCSSRP	Battle Creek Salmon and Steelhead Restoration Program
BMP	Best Management Practices
BO	Biological Opinion
BSSCP	Bentonite Slurry Spill Contingency Plan
CCV	California Central Valley
CDFG	California Department of Fish and Game
CDFW	California Department of Fish Wildlife
CEQA	California Environmental Quality Act
cfs	Cubic Feet per Second
CNFH	Coleman National Fish Hatchery
Corps	US Army Corps of Engineers
CRR	Cohort Replacement Rate
CV	Central Valley
CVP	Central Valley Project
CVFPB	Central Valley Flood Protection Board
CWA	Clean Water Act
CWT	Coded Wire Tag
dbh	Diameter at Breast Height
DCC	Delta Cross Channel
Delta	Sacramento-San Joaquin Delta
DO	Dissolved Oxygen
DPS	distinct population segment
DWR	California Department of Water Resources
DWSC	Deep Water Ship Channel
EFH	Essential Fish Habitat
EIP	Early Implementation Project
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
ETL	Engineering Technical Letter
FRFH	Feather River Fish Hatchery
GCID	Glenn-Colusa Irrigation District
GRS	General Reevaluation Study
HU	Hydrologic Unit
ITS	Incidental Take Statement
IWM	Instream Woody Material
JPE	Juvenile Production Estimate
Kelts	Post-Spawning Steelhead
lf	Linear Feet
LSNFH	Livingston Stone National Fish Hatchery
LWM	Large Woody Material
mm	millimeter

MMP	Mitigation and Monitoring Plan
MSA	Magnuson-Stevens Fishery Conservation and Management Act
nDPS	Northern Distinct Population Segment
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NTUs	Nephelometric Turbidity Units
O&M	Operation and Maintenance
PAHs	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PCE	primary constituent elements
PL	Public Law
PVA	Population Viability Analysis
RBDD	Red Bluff Diversion Dam
RD	Reclamation District
Reclamation	United States Department of the Interior, Bureau of Reclamation
RM	River Mile
RWQB	Regional Water Quality Control Board
SAM	Standard Assessment Methodology
SDFPF	Skinner Delta Fish Protection Facility
sDPS	Southern Distinct Population Segment
SJRRP	San Joaquin River Restoration Program
SPCCP	Spill Prevention, Control, and Counter-Measure Plan
SRA	Shaded Riverine Aquatic
SRBPP	Sacramento River Bank Protection Project
SRFCP	Sacramento River Flood Control Project
SWP	State Water Project
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TCP	Temperature Compliance Point
TFCF	Tracy Fish Collection Facility
TRT	Technical Review Team
USACE	United State Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
VSP	Viable Salmonid Populations
VVR	Vegetation Variance Request
WRDA	Water Resources Development Act
WRO	Water Rights Order
WSAFCA	West Sacramento Area Flood Control Agency

Note: Throughout this document there are references cited as CDFG. This refers to the California Department of Fish and Game. This name was changed to California Department of Fish and Wildlife on January 1, 2013. However, for consistency on publications, references prior to January 1, 2013, will remain CDFG.

INTRODUCTION

The U.S. Army Corps of Engineers (Corps) proposes to implement flood risk management improvements under the West Sacramento General Reevaluation Study (West Sacramento GRS). The purpose of this Biological Opinion (BO) is to analyze the potential effects from the West Sacramento GRS on listed threatened or endangered species and on designated critical habitat, within the project's area of effect (action area).

1.1 West Sacramento GRS Project Study Area

The West Sacramento Project study area refers to the area that will be protected by the proposed levee improvements, including the city of West Sacramento itself and the lands within West Sacramento Area Flood Control Agency (WSAFCA) boundaries, which encompass portions of the Sacramento River, the Yolo Bypass, and the Sacramento Deep Water Ship Channel (DWSC). The flood protection system associated with these waterways consists of over 50 miles of levees. These levees surround West Sacramento, with the exception of intersecting waterways (the barge canal and DWSC). The City of West Sacramento is located in eastern Yolo County at the confluence of the American and Sacramento rivers. The city lies within the natural floodplain of the Sacramento River, which bounds the city along the north and east. It is made up of a small amount of high ground north of Highway 50 along the Sacramento River, and reclaimed land protected from floods by levees and the Yolo Bypass system. The Yolo Bypass diverts flood flows around the city to the west. In addition to the area within the city limits (in Yolo County), the study area partially extends into Solano County on the extreme southwestern edge along the DWSC. The West Sacramento Project study area and the problems identified for improvement are shown on Figure 1.

The study area is within the bounds of the Legal Delta as defined by the State of California under the Delta Protection Act (Section 12220 of the Water Code). The Legal Delta is further subdivided into a primary zone and secondary zone for land use planning and resource protection purposes. Most of West Sacramento is in the secondary zone, while the extreme northern part of the city is outside of any of these Delta planning areas. The study reach along the DWSC west levee is the only portion of the study area within the primary zone.

The DWSC and barge canal bisect the city into two subbasins, separating the developing Southport area from the more established neighborhoods of Broderick and Bryte to the north (City of West Sacramento 2000). The two subbasins are broken up into nine levee reaches based on location and fixes. The North Basin, which encompasses 6,100 acres, contains:

1. Sacramento River north levee – 5.5 miles from the Sacramento Bypass south to the stone lock structure on the DWSC.
2. Port north levee – 4.9 miles from the stone lock structure west to the Yolo Bypass levee.
3. Yolo Bypass levee – 3.7 miles from the Port north levee north to the Sacramento Bypass. Sacramento Bypass Training levee – 0.5 miles west into the Yolo Bypass from the Sacramento Bypass levee.

The South Basin, which encompasses 6,900 acres, contains:

2. Sacramento River south levee – 5.9 miles south along the Sacramento River from the DWSC stone lock structure to the South Cross levee (just north of the waste water treatment plant).
3. South Cross levee – 1.2 miles across the South Basin from the Sacramento River to the DWSC.
4. DWSC east levee – 2.8 miles from the South Cross levee north to the point where it bends east.
5. Port south levee – 4.0 miles east from the bend in the DWSC east levee to the stone lock structure.
6. DWSC west levee – 21.4 miles from the intersection of the Port north levee and the Yolo Bypass levee south to Miners Slough.

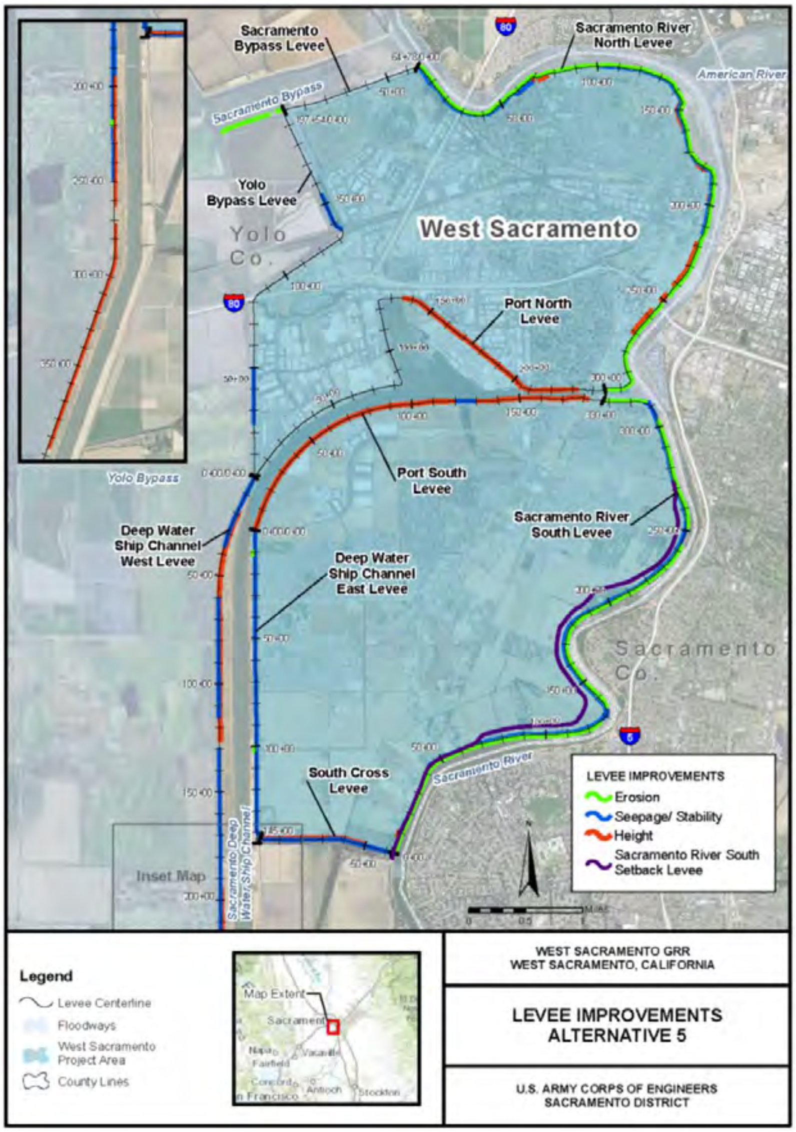

Figure 1. West Sacramento GRS Study Area (Corps 2014).

1.2 Background, Authority and Policy

The National Marine Fisheries Service (NMFS) prepared the BO and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR part 402.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System, https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts. A complete record of this consultation is on file at the NMFS California Central Valley Office.

1.2.1 Background

According to the Corps BA, the current levee system does not adequately protect the city of West Sacramento during a 100-year event. The history of the Sacramento River Flood Control Project (SRFCP) dates back to the mid-1800s with the initial construction of levees along the Sacramento, American, Feather, and Yuba rivers. This levee system has been characterized by a history of levee failure, followed by improvement. This continued until the California Legislature authorized a comprehensive plan for controlling the floodwaters of the Sacramento River and its tributaries in the Flood Control Act of 1911. Federal participation in the SRFCP began shortly after authorization in 1917 and continued for approximately 40 years.

Historically, from the mid-1800s onward, most hydraulic engineers at the Federal, State, and local level thought that the most effective way to control flood flows in the river system was to construct levees close to the main channel. The record floods of 1907 and 1909 forced a reevaluation of this historic approach. It was clear from the size of these flood events in relation to existing channel capacities that major bypass systems were needed to control excess flood flows. These bypasses were designed to divert flood flows away from urban centers. Throughout the SRFCP, the frequency that flow starts to divert from the Sacramento River to the bypass system varies between a 3-year to 5-year flood event.

The series of storms that struck California in February of 1986 resulted in the flood of record for many areas in northern and central California. As a result of the problems experienced during the 1986 flood, the Corps initiated a study of the levees comprising the SRFCP that were impacted by the flood. Due to the large scale of the study, the review was split into five phases. The first phase of this study included West Sacramento and was documented through an Initial Appraisal Report titled, Sacramento Urban Area Levee Reconstruction Project, California dated May 1988. This phase included the review of approximately 110 miles of levee and recommended the repair of 34 miles.

The 1986 flood also exposed structural problems and identified the inability of the existing levees to provide flood protection to the Sacramento metropolitan area. As a result, the Corps, in cooperation with the State of California, initiated the study titled, Sacramento Metropolitan Area, California, Feasibility Report. This report was published in February 1992 and indicated the existing flood control system in the study area provided significantly less than a 100-year level of protection. The study went on to recommend a program of improvements. The repairs recommended by the Sacramento Metropolitan Area, California, Feasibility Report were authorized in the Water Resources Development Act (WRDA) of 1992 (Public Law [PL] 102-580).

The Corps was preparing construction plans and specifications for the levee repairs authorized in the WRDA of 1992, when the 1997 New Year's Day Flood occurred. It was one of the largest experienced in northern California since the beginning of the measured record in 1906. In the wake of the 1997 flood, the Corps identified underseepage as an area of greater concern in the design and repair of levees. This resulted in a number of design revisions to the levee repairs recommended in the West Sacramento Project Design Memorandum. These design revisions and the associated increase to the total estimated project cost were captured in a supplemental authorization through the Energy and Water Development Appropriation Act of 1999 (PL 105-245).

There are two additional flood management Corps projects related to the West Sacramento GRS that provide additional context; the American River Common Features Project, and the Sacramento Bank Protection Project (SRBPP) Phase II 80,000 linear feet (lf). Many of the proposed elements associated with the American River Common Features and SRBPP are anticipated to be similar in nature to proposed elements with the West Sacramento GRS. The American River Common Features Project area will include the lower 8 miles of the American River and the east bank of the Sacramento River from the confluence of the American River downstream to the vicinity of Freeport, California. It will also include widening the Sacramento bypass and weir. Potential impacts associated with vegetation removal and bank armoring associated with the American River Common Features could further degrade this area of the Sacramento River watershed. These potential impacts in combination with potential impacts associated with the West Sacramento GRS could degrade the overall health of the lower Sacramento River watershed.

The Corps has initiated consultation for the Sacramento Bank Protection Project Phase II project. Sacramento Bank Protection Project Phase II will cover up to 80,000 lf of bank protection as part of the SRFCP. A number of the potential bank protection sites are located in the general vicinity of the West Sacramento GRS. These projects have the potential to increase the bank armoring and could exacerbate any impacts associated with the West Sacramento GRS.

1.2.2 Authority and Policy

According to the Corps' BA, they have no discretion in regards to the continuing existence and operation of the flood control structures of the SRFCP. The assert to have responsibility to maintain Civil Works structures so that they continue to serve their congressionally authorized purposes is inherent in the authority to construct them and is, according to the Corps, non-discretionary. The Corps also asserts that only Congressional actions to de-authorize the structures can alter or terminate this responsibility and thereby allow the maintenance of the structures to cease.

The Corps BA also claims that it has a non-discretionary duty to maintain the SRFCP and the fact the Corps perpetuates the projects existence is not an action subject to consultation. The Federal government maintains oversight but has no ownership of or direct responsibilities for performing maintenance of the Federal levee system, except for few select features that continue to be owned and operated by the Corps. However, the Corps asserts they do have discretion in regard to how and where maintenance actions are performed. The discretion lies within the authorities of the SRBPP and section 408 of the Rivers and Harbors Act. The Corps is seeking additional authorities that will include discretion over future flood risk reduction projects associated with the West Sacramento GRS and the American River Common Features.

Considering these exceptions, the Corps maintains that the majority of levees, channels, and related flood risk management structures are owned, operated, and maintained by the State of California and local levee and reclamation districts as governed by Corps Operations and Maintenance (O&M) manuals. The Corps points to the May 1955 Standard O&M manual for the SRFCP as the primary O&M manual for the area. The levees of the West Sacramento and Common Features Projects are part of the SRFCP and therefore covered in the 1955 O&M manual.

The BA states that following completion of construction, the Corps will prepare a supplement to the 1955 O&M manual which will specify maintenance requirements for these projects. Because the Corps does have discretion in how and when levee maintenance activities are performed (as opposed to the results of maintenance), maintenance is a discretionary activity that is part of the proposed action subject to consultation.

Typical maintenance activities would include vegetation control through mowing, herbicide application, and/or slope dragging; rodent control; patrol road maintenance; and erosion control and repair. Vegetation control typically would be performed twice a year. Herbicide and bait station application would be conducted under county permit by experts licensed by the state for pest control. Erosion control and slope repair activities would include re-sloping and compacting; fill and repair of damage from rodent burrows would be treated similarly.

To meet Federal Flood Control Regulations (33 CFR 208.10) and state requirements (California Water Code Section 8370), the Federal Flood Risk Management facilities are inspected four times annually, at intervals not exceeding 90 days. The California Department of Water Resources (DWR) would inspect the system twice a year, and the local maintaining authorities would inspect it twice a year and immediately following major high water events. The findings of these inspections would be reported to the Central Valley Flood Protection Board's (CVFPB) Chief Engineer through DWR's Flood Project Integrity and Inspection Branch.

Each federal agency has an obligation to insure that any discretionary action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or destroy or adversely modify its critical habitat. Furthermore, under Section 2 of the

ESA, it is declared that all Federal agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of the ESA. In regards to species and critical habitat compensation, the Corps has the authority to compensate prior to or concurrent with project construction impacts. This authority is given under WRDA 1986 (33 USC §§ 2201–2330).

The West Sacramento Project is being proposed in accordance with the principles that have been outlined in the Corps' SMART Planning Guide (Corps 2013). SMART Planning requires that all feasibility studies should be completed within a target of 18 months (to no more than three years at the greatest), at a cost of no more than $3 million, utilizing 3 levels of vertical team coordination, and of a "reasonable" report size. All designs associated with the West Sacramento Project use the largest footprint to evaluate affects to listed species. The larger footprint will look at the maximum extent the project could affect species in the action area.

The Corps proposes to construct the West Sacramento Project levee improvement measures to comply with the Engineering Technical Letter (ETL) 1110-2-571 Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures. The vegetation requirements include a vegetation-free zone on the levee slopes and crown, 15 feet from both landside and waterside levee toes, and 8 feet vertically.

The levees within the study area require seepage, slope stability, height, and erosion improvements in order to meet Corps levee safety criteria. In order to protect existing vegetation and allow for revegetation to occur, the Corps must apply for and issue itself with a vegetation variance. The vegetation variance will be sought during the preconstruction engineering and design phase to allow vegetation to remain on the lower 2/3 of the waterside slope and out 15 feet from the waterside toe. If the Corps grants itself a variance, the variance would allow for vegetation to remain in these areas. No vegetation would be permitted on the landside slope or within 15 feet of the landside toe. To show that the safety, structural integrity, and functionality of the levee would be retained with a variance, an evaluation of underseepage and waterside embankment slope stability was completed by Corps engineers.

The Corps' preliminary analysis for the vegetation variance was conducted by analyzing two index points. These two index points were chosen for the vegetation variance analyses because they were considered to be representative of the most critical channel and levee geometry, underseepage, slope stability conditions, and vegetation conditions of the respective basins. The analysis incorporated tree fall and scour on the cross-section geometry of the index points by using a maximum depth of scour for cottonwoods as approximately 11.0 feet; the associated soil removed was projected at a 2:1 slope from the base of the scour toward both the landside, and waterside slopes. The base scour width was equal to the maximum potential diameter at breast height (dbh) of cottonwoods (12.0 feet) projected horizontally at a depth of 11.0 feet below the existing ground profile. The results show that the tree fall and scour did not significantly affect levee performance and that the levee would meet Corps seepage and slope stability criteria when the seepage and slope stability improvement measures are in place ("with-project" conditions). Therefore, it is a reasonable conclusion that allowing vegetation to remain on the lower waterside levee slope would not affect the safety, structural integrity, and functionality of the Sacramento River levee.

As a result of the geotechnical analysis, the Corps would request a vegetation variance of themselves for the Sacramento River portion of future projects that come from the GRS. In many cases along the Sacramento River levees, the levee is far enough back from the water's edge to allow vegetation providing shaded riverine aquatic cover to remain on the bank with no vegetation variance necessary. However, in Sacramento River north reach, vegetation along the bank will be thinned in order to place rock on the bank for erosion protection. No woody vegetation would be permitted on the landside slope or within 15 feet of the landside toe for purposes of providing access for levee inspections and flood repair response. Refer to Table 1 for reach specific information regarding presence or absence of a vegetation variance.

Table 1: West Sacramento Project Vegetation Variance Assumptions.

Repair Reach	Vegetation Variance	No Vegetation Variance
Sacramento River North	X	
Port North		X
Yolo Bypass *		X
Sacramento Bypass Training Levee		X
Sacramento River South	X	
South Cross		X
Deep Water Ship Channel East *		X
Deep Water Ship Channel West*		X
Port South		X

*Vegetation is sparse in these reaches. Individual tree removal will be analyzed.

Approximately 50 acres of primarily landside riparian vegetation will be removed, both to provide for the construction footprint, and to comply with ETL. In addition, approximately 5,000 linear feet (lf) of shoreline habitat will be removed from the Port north and south levees along the Barge Canal due to ETL compliance.

The standard O&M activities will be adjusted to reflect any vegetation variance. Under the adjusted O&M manual, large trees that were protected in place under the variance will be allowed to remain on the waterside slopes, but smaller shrubs will be removed and grasses will be regularly mowed to allow for inspection and access.

The initial study authority for the West Sacramento area was provided through Section 209 of the Flood Control Act of 1962, PL 87-874. The West Sacramento Project was authorized in WRDA 1992, PL 102-580 Sec. 101 (4), as amended by the Energy and Water Development of 1999, PL 105-245. It was reauthorized on October 28, 2009, with a total project cost of $53,040,000 under WRDA 2010, PL 111-85.

1.3 Consultation History

NMFS received a request for initiation of consultation on June 10, 2014. However, the initial request did not contain an appropriate effects determination. The Biological Assessment (BA) was missing necessary information to perform a species impact analysis. After phone conversations, emails, and inter-agency meetings, the Corps agreed to send out a revised initiation letter along with an updated BA. The revised initiation letter was dated November 24, 2014. The revised BA was delivered on November 24, 2014 (Corps 2014) and determined that the West Sacramento GRS will adversely affect threatened Central Valley (CV) spring-run Chinook salmon evolutionarily significant unit (ESU) (*Oncorhynchus tshawytscha*), endangered Sacramento River winter-run Chinook salmon ESU (*O. tshawytscha*), threatened California CV (CCV) steelhead distinct population segment (DPS) (*O. mykiss*), and threatened Southern DPS (sDPS) of North American green sturgeon (*Acipenser medirostris*), and their designated critical habitats. Additionally, the Corps has determined that the West Sacramento Project may adversely affect Essential Fish Habitat (EFH) pursuant to the Magnunson-Stevens Fishery Management Act. The Corps also states that there is an expectation that the West Sacramento GRS (particularly the Southport EIP project) may benefit long-term EFH quality in the action area.

For much of this process, coordination with the Corps occurred independently on the Southport EIP and the portions of the West Sacramento GRS that occur outside the Southport EIP. On April 21, 2014, an interagency meeting was held to discuss the BAs for both actions. In part, as a result of that meeting, the Corps decided to combine the two BAs because the two projects were determined to be too related to be considered in two separate consultations. The Corps and WSAFCA, consulted with NMFS regarding proposed actions that may affect Federally listed species and their habitat.

1. 2008 through 2010—NMFS staff participated in site visits and meetings associated with WSAFCA's overall levee improvements program, leading to completed consultations for The Rivers, and California Highway Patrol Academy projects.
2. May 26, 2011—NMFS staff participated in the kick-off of an environmental stakeholder group for the Southport EIP.
3. August 15, 2011—NMFS staff participated in an informal meeting of the Southport EIP environmental stakeholder group and attended a field visit led by WSAFCA.
4. November 14, 2011—NMFS staff participated in an environmental stakeholder group meeting on project alternatives development.
5. March 28, 2013—NMFS staff participated in National Environmental Policy Act/California Environmental Quality Act (NEPA/CEQA) scoping meeting.
6. June 4, 2013—Corps requested initiation of consultation with NMFS on the Southport EIP.
7. August 27, 2013 – NMFS staff met with WSAFCA and Corps staff to discuss project design and BA comments.
8. September 30, 2013 – NMFS staff correspondence requested additional information from the Corps to support consultation.
9. December 11 and 18, 2013— NMFS staff participated in public meetings on the Southport EIP Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR).

10. December 18, 2013 – NMFS staff participated in an environmental stakeholder group meeting on project design development.
11. June 10, 2014 – NMFS received an initiation letter from the Corps for the West Sacramento Project, General Reevaluation Report.
12. September 9, 2014 – NMFS delivered an insufficiency letter to the Corps requesting a revised BA and initiation letter.
13. October and November 2014 – The Corps and NMFS had a number of meetings, phone calls, emails, and related correspondence with the purpose of producing a revised BA and updated initiation letter.
14. November 24, 2014 – NMFS received a revised initiation letter and BA for the West Sacramento, General Reevaluation Study.
15. On March 5, 2015, the Corps requested NMFS to issue separate BOs for the Southport EIP and the West Sacramento GRS to facilitate the construction schedule of the Southport EIP which is planned to start construction in summer of 2015.
16. On March 19, NMFS met with the Corps, and WSAFCA staff to discuss coordination of these projects as two separate consultations. WSAFCA and the Corps clarified that although they requested separate BOs for each action, the projects are only related in that the reclaimed floodplain area of the Southport EIP may be used to offset some of the unavoidable adverse effects of future West Sacramento GRS-related actions.
17. On March 19, 2015, NMFS initiated formal consultation on the West Sacramento GRS.
18. On July 1, 2015, NMFS transmitted a draft BO to the Corps for review pursuant to the draft interagency SMART planning guidelines. The draft BO concluded that the proposed action is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead or destroy adversely modify their designated critical habitat and that the proposed action is likely to jeopardize the continued existence of sDPS green sturgeon and it will destroy or adversely modify their designated critical habitat. The conclusion regarding green sturgeon.
19. NMFS and the Corps met on July 14 and 15, 2015, and again on August 11, 2015 to discuss Corps comments on the draft BO. The meeting discussions focused on the draft Reasonable and Prudent Alternative, Reasonable and Prudent Measures and Terms and Conditions. During the final meeting the NMFS and the Corps discussed options for integrated the RPA actions into the proposed action.
20. On August 27, the Corps transmitted a letter the NMFS adopting the green sturgeon conservation measures that were previously referred to as the Reasonable and Prudent Alternative in the draft jeopardy BO as part of the proposed action.

1.4 Proposed Action

“Action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02).

The Corps has identified a number of problems associated with the flood risk management system protecting the city of West Sacramento and surrounding areas. There is a high probability that flows in the American and Sacramento rivers will stress the network of levees protecting West Sacramento to the point that levees could fail. Such a levee failure would flood a highly urbanized area.

Levees in the West Sacramento GRS action area require improvements to address seepage, slope stability, overtopping, and erosion concerns. The measures proposed to improve the levees consist of: (1) seepage cutoff walls, (2) seepage berms, (3) stability berms, (4) levee raises, (5) flood walls, (6) relief wells, (7) sheet pile walls, (8) jet grouting, and (9) bank protection. The above measures will be implemented by fixing levees in place, constructing adjacent levees, or constructing a setback levee. It is possible that sheet pile walls, jet grouting, and relief wells will be used at various locations so they are also described below. Once a levee is modified, regardless of the measure implemented for the alternative, the levee will be brought into compliance with Corps levee design criteria. This will include slope flattening and/or crown widening, where required. The levee crown will be widened to 20 feet, and 3:1 landside and waterside slopes will be established where possible. If necessary, the existing levee centerline will be shifted landward in order to meet the Corps' standard levee footprint requirements.

For more details on the potential levee repairs listed above and in Table 1, refer to the West Sacramento, California General Reevaluation Study and Section 408 Permission, specifically Chapter 2 (Corps 2014).

In addition to the proposed levee improvements measures, the following measures and policies will apply to all of the levee repair alternatives, and will be addressed during construction:

1. The Corps' standard levee footprint will be established during construction of structural improvements on all levees that are out of compliance. The standard levee footprint consists of a 20 foot crown width and 3:1 waterside and landside slopes. If the 3:1 landside slope is not possible based on site specific conditions then a minimum 2:1 landside slope will be established with supporting engineering analysis.
2. A 20 foot landside and waterside maintenance access will be established. In areas where 20 feet cannot be obtained, 10 feet will be allowable.
3. Utility encroachments such as structures, certain vegetation, power poles, pump stations, and levee penetrations (e.g., pipes, conduits, cables) will be brought into compliance with applicable Corps policy or removed depending on type and location. This measure will include the demolition of such features and relocation or reconstruction as appropriate on a case-by-case basis (or retrofit to comply with standards). Utilities replacements will occur via one of two methods: (1) a surface line over the levee prism, or (2) a through-levee line equipped with positive closure devices.
4. Private encroachments shall be removed by the non-federal sponsor prior or property owner prior to construction.

The O&M of the levees in the West Sacramento area are the responsibility of the local maintaining agencies, including Reclamation District (RD) 900, RD 537, DWR's Maintenance Area 4, and the Corps. The applicable O&M Manual for the West Sacramento levees is the Standard O&M Manual for the Sacramento River Flood Control Project. Typical levee O&M in the West Sacramento area includes the following actions:

1. Vegetation maintenance up to four times a year by mowing or applying herbicide.
2. Control of burrowing rodent activity monthly by baiting with pesticide.
3. Slope repair, site-specific and as needed, by re-sloping and compacting.

4. Patrol road reconditioning up to once a year by placing, spreading, grading, and compacting aggregate base or substrate.
5. Visual inspection at least monthly, by driving on the patrol road on the crown and maintenance roads at the base of the levee.

For levee repair sites with a vegetation variance, the O&M manual will be adjusted to reflect the variance. Under the adjusted O&M manual, large trees that were protected in place under the variance will be allowed to remain on the waterside slopes, but smaller shrubs will be removed and grasses will be regularly mowed to allow for inspection and access.

Flood risk reduction construction activities will primarily occur during the April 15 to October 31 time frame, although extension of the CVFPB encroachment permit may be sought if weather conditions permit. However, construction activities, including, but not limited to, structure and vegetation removal, roadway removal and replacement, revegetation, and utility removal and replacement, regardless of the construction season will be subject to the conditions of environmental and encroachment permits and authorizations to be issued by the California Department of Fish and Wildlife (CDFW), CV Regional Water Quality Control Board (RWQCB), CVFPB, the Corps, US Fish and Wildlife Service (USFWS), NMFS, Yolo County, City of West Sacramento, and others.

Construction of the West Sacramento Project is proposed to take approximately 19 years if each reach is constructed sequentially. The construction reaches have been prioritized based on a variety of factors, including the condition of the levee, the potential damages that will occur due to levee failure, and construction feasibility considerations, such as the availability of equipment at any given time. A summary of the flood risk reduction measures proposed as part of this study are included in Table 2.

Table 2. Proposed Measures for the West Sacramento Project

	Extent of Action	**Proposed Measure**
North Basin		
Sacramento River North Levee *	5.5 miles from the Sacramento Bypass south to the stone lock structure on the DWSC.	• Construct bank protection • Install cutoff walls • Construct levee raise
West Sacramento Port North Levee **	4.9 miles from the stone lock structure west to the Yolo Bypass levee.	• Construct floodwalls
Yolo Bypass **	3.7 miles from the Port North levee north to the Sacramento Bypass.	• Install cutoff walls
Sacramento Bypass Training Levee **	1.1 miles from the Yolo Bypass levee to the Sacramento River.	• Construct bank protection
Sacramento River South Levee *	5.9 miles south along the Sacramento River from the DWSC stone lock structure to the South Cross levee.	• Construct bank protection • Install cutoff walls • Construct levee raise • Construct seepage berm • Construct setback levee
South Cross Levee **	1.2 miles across the South Basin from the Sacramento River to the DWSC.	• Install cutoff walls • Construct seepage berms • Levee Raise
Deep Water Ship Channel East Levee **	2.8 miles from the South Cross levee north to the point where it bends east.	• Construct floodwalls • Levee raise • Construct bank protection
West Sacramento Port South Levee **	4.0 miles east from the bend in the DWSC east levee to the stone lock structure.	• Install cutoff walls • Construct levee raise
Deep Water Ship Channel West Levee **	21.4 miles from the intersection of the Port North levee and the Yolo Bypass levee south to Miners Slough.	• Install cutoff walls • Construct seepage berms • Levee raise • Construct bank protection • Construct closure structure
South Cross Levee **	1.2 miles across the South Basin from the Sacramento River to the DWSC.	• Install cutoff walls • Construct seepage berms • Levee Raise

* Will establish compliance with Corps vegetation requirements for upper 2/3 slopes of the levee, with a variance allowing the lower 1/3rd waterside vegetation to stay.
** Will establish compliance with Corps vegetation requirements. ETL 1110-2-571

The tentative schedule of construction is shown in Table 3. The durations are for construction activities only, and do not include the time needed for design, right-of-way, utility relocation, etc.

Analysis of total linear feet (lf) of shaded riverine aquatic (SRA) habitat in the West Sacramento Project area was conducted (Table 4). The Sacramento Bypass Training levee, Yolo Bypass, and South Cross levee reaches were not evaluated because there is minimal, if any, SRA associated with these reaches. There also could be the potential for habitat removal in the Sacramento Bypass during the widening process but will wait for analysis and future ESA consultation once future designs are presented.

Table 3. West Sacramento Project Construction Sequence and Duration

Constructing Sequence	Constructing Duration
River South Levee	4 years
Sacramento Bypass Training Levee	1 years
Sacramento River North Levee	2 years
Yolo Bypass	1 years
DWSC West	3 years
Port South	1 years
DWSC East	3 years
South Cross	2 years
Port North	2 years

Table 4. SRA Reach Specific Summary

Project Reach	Linear Feet
Port North Levee	2,468
Port South Levee	2,602
Sacramento River North Levee	27,241
Sacramento River South Levee	16,047
Total SRA	48,358

The Corps will need to remove some SRA habitat in order to place rock along the river bank, but more than half of the existing SRA habitat along the 11 miles of Sacramento River levees will remain in place. A variance will also be sought for these levee reaches, allowing 34 acres of riparian habitat on the lower one-third of the slope to 15 feet waterward of the waterside levee toe to remain in place.

1.11 Conservation Actions

The Corps will seek to avoid and minimize construction effects on listed species and their critical habitat to the extent feasible, and will implement on-site, and off-site compensation actions as necessary. Compensation time is the time required for on-site plantings to provide significant amounts of shade or structural complexity. Depending on project impacts, a project may incorporate various habitat and species benefits to compensate for short-term losses in habitat for listed species. Long-term compensation to offset short-term losses is generally not an option for the loss of critical habitats under the ESA (USFWS 1998a). The Corps uses the following compensation time periods (based loosely on life expectancy) as guidelines for compensation:

- Green sturgeon, 15 years;
- Chinook salmon, 5 years; and
- Central Valley steelhead, 4 years (Corps 2012).

1. Implement best management practices (BMPs) to prevent slurry seeping out to river and require piping system on land side only.
2. The Corps will incorporate compensation for SRA habitat losses either by project constructed compensation sites or in combination with purchase of credits at a NMFS approved conservation bank where appropriate.
3. The Corps will seek an ETL-approved vegetation variance exempting the Sacramento River sites from vegetation removal in the lower one-third of the waterside of the levee prior to final construction and design phase. Construction may require removal of vegetation on the upper two-thirds of the waterside and landside slope. Full ETL compliance will occur on the Sacramento and Yolo bypasses, Yolo Bypass Toe Drain, South Cross levee, and the DWSC, Barge Canal, and Port of West Sacramento levee reaches.
4. The Corps will use a rock soil mixture to facilitate re-vegetation of the project sites that require bank protection work. A (70:30) rock to soil ratio will be implemented. The soil-rock mixture will be placed on top of the of the rock revetment along the Sacramento River levees to allow native riparian vegetation to be planted to insure that SRA habitat lost is replaced or enhanced.
5. In addition to an approved vegetation variance, the Corps will minimize the removal of existing vegetation in the proposed project area. Disturbance or removal of trees or larger woody vegetation will be replaced with native riparian species, outside of the vegetation-free zone, as established in the ETL.
6. Levee repair designs will be analogous to those developed for an SRBPP repair site. These levee repair designs include installation of IWM, native vegetation planting, incorporation of soil with the rock, etc.
7. Construction will be scheduled when listed terrestrial and aquatic species will be least likely to occur in the project area. If construction needs to extend into the timeframe that species are present coordination with the resource agencies will occur.
8. Stockpile construction materials such as portable equipment, vehicles, and supplies, at designated construction staging areas and barges, exclusive of any riparian and wetlands areas.

9. Stockpile all liquid chemicals and supplies at a designated impermeable membrane fuel and refueling station with a containment system.
10. Erosion control measures including Storm Water Pollution Prevention Program (SWPPP) and Water Pollution Control Program that minimize soil or sediment from entering the river. BMPs shall be installed, monitored for effectiveness, and maintained throughout construction operations to minimize effects to federally listed fish and their designated critical habitat.
11. Site access will be limited to the smallest area possible in order to minimize disturbance.
12. Litter, debris, unused materials, equipment, and supplies will be removed from the project area daily. Such materials or waste will be deposited at an appropriate disposal or storage site.
13. Immediately (within 24 hours) cleanup and report any spills of hazardous materials to the resource agencies. Any such spills, and the success of the efforts to clean them up, shall also be reported in post-construction compliance reports.
14. Designating a Corps-appointed representative as the point-of-contact for any contractor who might incidentally take a living, or find a dead, injured, or entrapped threatened or endangered species. This representative shall be identified to the employees and contractors during an all employee education program conducted by the Corps.
15. Vegetation removed as a part of ETL compliance will be compensated on site, outside of the vegetation-free zone, to the extent feasible. When on-site compensation is not feasible, compensation is proposed at local conservation banks with available credits. If credits are not available locally, then compensation is proposed to occur within the West Sacramento city limits.
16. The Corps will compensate for any short and longer term impacts through additional onsite compensation, purchase of compensatory conservation credits, or development of suitable created aquatic habitat.
17. Screen any water pump intakes.

A number of measures will be applied to the entire West Sacramento Project or specific actions, and other measures may be appropriate at specific locations within the West Sacramento Project study area. Avoidance activities to be implemented during final design and construction may include, but are not limited to, the following:

1. Identifying all habitats utilized by listed terrestrial, wetland, and plant species in the potentially affected project areas. To the extent practicable efforts will be made to minimize effects by modifying engineering design to avoid potential direct and indirect effects.
2. Incorporating sensitive habitat information into project bid specifications.
3. Incorporating requirements for contractors to avoid identified sensitive habitats into project bid specifications.
4. Minimizing vegetation removal to the extent feasible.
5. Minimizing, to the extent possible, grubbing and contouring activities.

1.12 Additional Conservation Measures for sDPS Green Sturgeon

In response to the draft BO and through collaboration with NMFS, the Corps has updated the project description in the Environmental Impact Statement/Environmental Impact Report (EIS/EIR) and will implement the following additional measures that have been coordinated with NMFS to reduce impacts to green sturgeon habitat.

1. The Corp's final EIS/EIR for the West Sacramento Project shall include a proposal to develop a green sturgeon habitat, mitigation, and monitoring plan (HMMP) with the specific elements that are described below.

   The goal of developing the HMMP is to ensure that adverse impacts of future West Sacramento projects on sDPS green sturgeon are sufficiently mitigated in order to allow for the growth, survival, and recovery of the species in the study area.

2. The green sturgeon HMMP shall be developed in coordination with the Interagency Ecological Program (IEP) green sturgeon project work team and consulted on with NMFS prior to the construction of any work within the designated critical habitat of sDPS green sturgeon related to the West Sacramento Project. The HMMP should focus on filling important data gaps on green sturgeon life history and micro and macro habitat ecology in both the Sacramento River and the north Delta within the project impact area, in regard to how bank stabilization measures proposed in the West Sacramento Project affect sturgeon ecology and survival.

   The goal of this conservation measure is to leverage the resources of the IEP to help develop an HMMP that utilizes and applies the best available scientific expertise and information available.

3. The Corps shall either refine the Standard Assessment Methodology (SAM) or develop an alternative green sturgeon survival and growth response model based on using and updating the existing Hydrologic Engineering Center Ecosystem Function Model that reflects green sturgeon's preference for benthic habitat and that accounts for the physical loss of habitat from revetment footprints instead of the convention used by the SAM where the fish response is evaluated at the intersect of seasonal water surface elevations. The new modeling may include hydraulic modeling, but must be capable of evaluating green sturgeon survival in response to levee repair projects in the project impact area and the effects on all habitat conditions, not exclusively flow changes. Development of the model shall be initiated at the start of the preconstruction engineering and design (PED) phase of the West Sacramento Project and shall be peer reviewed by sturgeon experts on the IEP, other academia with sturgeon expertise, and be consulted on with NMFS.

   The goal of this measure is to develop a functional assessment methodology using the best available scientific expertise and information available to model the effects of future West Sacramento Project actions and evaluate the performance of mitigation actions relative to the survival and growth of sDPS green sturgeon that are exposed to such actions.

4. The HMMP shall also restore or compensate for the number of acres and ecological function of soft bottom benthic substrate for sDPS green sturgeon permanently lost to project construction. This mitigation shall be coordinated with the Interagency Working Group or a Bank Protection Working Group and must be carried out within the lower Sacramento River/North Delta in order to offset the adverse modification to designated critical habitat. The restored habitat must be capable of providing abundant benthic prey, freshwater or estuarine areas with adequate water quality, temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth and viability of all life stages. It should also provide safe and unobstructed migratory pathways necessary for timely passage of adult, sub-adult, and juvenile fish within the region's different estuarine habitats and between the upstream riverine habitat and the marine habitats. The restoration/mitigation shall be initiated prior to commencement of construction within the designated critical habitat of sDPS green sturgeon for the West Sacramento Project and the updated model should be used to validate performance. The restoration site and plan shall be developed in coordination with the IEP and be consulted on with NMFS.

   The goal is to ensure the spatial and temporal ecological impacts from project-related permanent loss of critical habitat for green sturgeon and critical for juvenile green sturgeon migration are fully compensated.

5. The green sturgeon HMMP shall also be developed with measurable objectives for completely offsetting all adverse impacts to all life stages of sDPS green sturgeon (as modeled using refined approaches described in Measure C, above, and considering design refinements that occur in the PED phase of project implementation).

   The goal of this measure is to develop "SMART" objectives for mitigation. "SMART" objectives are specific (target a specific area for improvement), measurable (quantify or suggest an indicator of progress), attainable (specify who will do the work and if possible how), realistic (state what results can realistically be achieved, given available resources) and timely (specify when the results can be achieved) habitat performance objectives for green sturgeon mitigation.

6. Mitigation actions shall be initiated prior to the construction activities affecting sDPS green sturgeon and their critical habitat. Specific mitigation plans may be developed during project design engineering to reduce the specific impacts of levee construction actions.

   The goal of this measure is to ensure that mitigation coincides with project implementation and minimizes, to the maximum extent possible, extended temporal effects.

7. The sDPS green sturgeon HMMP will include measurable performance standards at agreed upon intervals and will be monitored for a period of at least ten years following construction. If additional monitoring is necessary, the monitoring shall be included in the project operations and maintenance plan and carried out by the local sponsor. The

HMMP will include adaptive management strategies for correcting any mitigation measures that do not meet performance standards.

The goal of this measure it to provide a reasonable amount of time to measure performance standards after mitigation occurs to ensure that it meets the objectives of the HMMP.

1.13 Interrelated and Interdependent Actions

"Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR 402.02). In this case, there are no interrelated or interdependent actions.

Although the West Sacramento GRS is associated with the Southport EIP in that some of the riparian habitat impacts of West Sacramento will be mitigated at the Southport location, they are not interrelated or interdependent because neither project depends on the other for their justification and they both have independent utility.

The specific association of the two projects is that the Southport EIP will include the development of a NMFS-approved MMP that will include an accounting plan to quantify the extent of Southport offsets and the potential for future offsets available for the West Sacramento GRS. The MMP will provide the accounting plan that will link the amount of offset area available at the Southport EIP with West Sacramento impacts.

1.14 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02).

The action area for the West Sacramento GRS includes the Sacramento River from the Sacramento Bypass down to the South Cross levee, the Sacramento DWSC and Port of West Sacramento, and the Sacramento and Yolo bypasses.

The action area includes perennial waters of the Sacramento River extending 200 feet perpendicular from the average summer-fall shoreline and 1,000 feet downstream from proposed in-water construction areas. This represents the potential area of turbidity and sedimentation effects based on the reported limits of visible turbidity plumes in the Sacramento River during similar construction activities (NMFS 2008).

ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, Federal agencies must ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions will affect listed species and their critical habitat. If incidental take is expected, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This BO includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that will be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

The adverse modification analysis considers the impacts of the Federal action on the conservation value of designated critical habitat. This BO does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.[1]

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

1. Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.
2. Describe the environmental baseline in the action area.
3. Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.
4. Describe any cumulative effects in the action area.
5. Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat.
6. Reach jeopardy and adverse modification conclusions.
7. If necessary, define a reasonable and prudent alternative to the proposed action.

2.1.1 Use of Analytical Surrogates

The effects of the West Sacramento GRS are primarily analyzed using Standard Assessment Methodology (SAM). The Corps provided the background data, assumptions, analyses, and assessment of habitat compensation requirements for the federally protected fish species relevant to this consultation.

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[1] Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (November 7, 2005).

The SAM was designed to address a number of limitations associated with previous habitat assessment approaches and provide a tool to systematically evaluate the impacts and compensation requirements of bank protection projects based on the needs of listed fish species.

It is a computational modeling and tracking tool that evaluates bank protection alternatives by taking into account several key factors affecting threatened and endangered fish species. By identifying and then quantifying the response of focal species to changing habitat conditions over time, project managers, biologists and design engineers can make changes to project design to avoid, minimize, or compensate for impacts to habitat parameters that influence the growth and survival of target fish species by life stage and season. The model is used to assess species responses as a result of changes to habitat conditions, either by direct quantification of bank stabilization design parameters (*e.g.,* bank slope, substrate).

In 2003, the Corps established a program to carry out "a process to review, improve, and validate analytical tools and models for USACE Civil Works business programs". Reviews are conducted to ensure that planning models used by the Corps are technically and theoretically sound, computationally accurate, and in compliance with the Corps planning policy. As such, all existing and new planning models developed by the Corps are required to be certified through the appropriate Planning Center of Expertise and Headquarters in accordance with Corps rules and procedures.

The assumptions, model variables, and modeling approaches used in the SAM have been developed to be adapted and validated through knowledge gained from monitoring and experimentation within the SRBPP while retaining the original overall assessment method and framework. The first update to the SAM included the addition of sDPS green sturgeon as well as a number of modifications to modeled-species responses based upon updated literature reviews and recent monitoring efforts at completed bank protection sites (Stillwater Sciences 2009, USACE 2009).

In late 2010, the certification process for the SAM was initiated by the Corps, Sacramento District in coordination with the Ecosystem Planning Center of Expertise. The process entailed charging a panel of six experts to review the SAM, along with the SAM (version 3.0). The Review Panel was composed of a plan formulation expert, fisheries biologist, aquatic ecologist, geomorphologist/geologist, population biologist/modeling expert, and software programmer.
A major advantage of the SAM is that it integrates species life history and seasonal flow-related variability in habitat quality and availability to generate species responses to project actions over time. The SAM systematically evaluates the response of each life stage to habitat features affected by bank protection projects.

The SAM quantifies habitat values in terms of a weighted species response index (WRI) that is calculated by combining habitat quality (i.e., fish response indices) with quantity (i.e., bank length or wetted area) for each season, target year, and relevant species/life stage. The fish response indices are derived from hypothesized relationships between key habitat attributes (described below) and the species and life stage responses. Species response indices vary from 0 to 1, with 0 representing unsuitable conditions and 1 representing optimal conditions for survival, growth, and/or reproduction. For a given site and scenario (i.e., with or without project), the SAM uses these relationships to determine the response of individual species and life stages to the measured or predicted values of each habitat attribute for each season and target year, and then multiplies these values together to generate an overall species response index. This index is then multiplied by the linear feet or area of shoreline to which it applies to generate a weighted species response index expressed in feet or square feet. The species WRI provides a common metric that can be used to quantify habitat values over time, compare project conditions to existing conditions, and evaluate the effectiveness of on-site and off-site compensation actions.

The WRI represent an index of a species growth and survival based on a 30-day exposure to post project conditions over the life of the project. As such, negative SAM values can be used as a surrogate to quantify harm to a target fish species by life stage and season. Also, although SAM values represent and index of harm to a species, since the values are expressed as "weighted bankline feet" or "weighted area", these values can be used to help quantify compensatory conservation actions such as habitat restoration, and are used for that purpose in this BO.

During the process of this consultation, the Corps and NMFS identified several short comings with the SAM as a tool for reliably forecasting the growth and survival of green sturgeon. The primary short coming is that the SAM evaluates habitat conditions at the seasonal water surface intersect with the river bank. While this is considered an effective point for measuring salmon and steelhead habitat, green sturgeon have a greater affinity for benthic habitat than shoreline habitat. Further, during discussions between the Corps and NMFS, it was widely agreed upon that levee repair actions in the West Sacramento Study Area are likely to only affect the juvenile rearing life stage and probably have little to no adverse impacts on the adult life stages of green sturgeon because spawning habitat is not present and adults that are migrating upstream are probably more influenced by impacts that affect swimming speed and upstream passage than shoreline habitat manipulations. Because of this, NMFS has decided to use the SAM as a proxy for quantifying habitat disturbance and harm and use as an ecological surrogate for quantifying the amount and extent of take for juvenile rearing and migrating green sturgeon, but the precision is not as sharp as for salmon and steelhead. Therefore, a new model will be developed to determine compensatory mitigation actions and tracking performance.

2.1.2 Compensation Timing

As described in the proposed action, projects such as this often propose compensation for unavoidable short-term effects to species and impacts to habitat. These compensation timeframes are generally based on anticipated SAM response time. Under the Corps BA, compensation timing is defined and in practice adopts an approach that the SAM modeled impact at the proposed timing (Green sturgeon: 15 years: Chinook salmon, 5 years: Central Valley steelhead, 4 years) is sufficient to compensate for project effects. NMFS adopts a slightly different approach to the analysis of the BO in that the compensation time should be a target for avoiding exposure of more than one generation of a population with a multiple age class structure. Negative SAM-modeled values beyond those years, especially at winter and spring water surface elevations, may have significant effects to the species and impacts to critical habitat that would reduce the species survival and recovery in the wild or substantially reduce the conservation value of the species because the adverse effects (reduced growth and survival of individuals) would begin to reduce the number of reproducing individuals across multiple generations. In some cases, negative SAM values extend beyond these compensation periods, in which case offsite compensatory mitigation can reduce the long-term effects to a species survival and recovery by creating high quality habitat conditions in areas that provide high ecological value for the species. Because we have determined the SAM model is not a strong representation of green sturgeon growth and survival response, we are applying the implementation of the USACE Green Sturgeon Conservation Measures As key actions necessary to both avoid reducing the survival and recovery of the species in the wild and reducing the conservation value of critical habitat, instead of applying a specific compensation time period for green sturgeon. As such, this BO applies the following compensation timing as general targets for avoiding such long-term effects to salmon and steelhead:

1. Chinook salmon, 5 years;
2. Central Valley steelhead, 4 years

2.2 Rangewide Status of the Species and Critical Habitat

This BO examines the status of each species that will be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The BO also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential physical and biological features that help to form that conservation value.

One factor affecting the rangewide status of the CV spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, CCV steelhead, and the North American green sturgeon, and aquatic habitat at large is climate change.

The following federally listed species and designated critical habitats occur in the action area and may be affected by the proposed action:

Sacramento River winter-run Chinook salmon ESU (*Oncorhynchu tshawytscha*) Listed as endangered (70 FR 37160, June 28, 2005)

Sacramento River winter-run Chinook salmon designated critical habitat (June 16, 1993, 58 FR 33212)

CV spring-run Chinook salmon ESU (*O. tshawytscha*) Listed as threatened (70 FR 37160, June 28, 2005)

CV spring-run Chinook salmon designated critical habitat (70 FR 52488, September 2, 2005)

CCV steelhead DPS (*O. mykiss*)
Listed as threatened (71 FR 834, January 5, 2006)

CCV steelhead designated critical habitat
(70 FR 52488, September 2, 2005)

Southern DPS of North American green sturgeon (*Acipenser medirostris*)
Listed as threatened (71 FR 17757, April 7, 2006)

Southern DPS of North American green sturgeon designated critical habitat (74 FR 52300, October 9, 2009)

Critical habitat designations identify those physical and biological features of the habitat that are essential to the conservation of the species and that may require special management consideration or protection. Within the West Sacramento GRS this includes the river water, river bottom, and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent is defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of one to two years on the annual flood series) used by listed salmonids and sturgeon.

NMFS has recently completed an updated status review of five Pacific salmon ESUs and one steelhead DPS, including Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon and CCV steelhead, and concluded that the species' status should remain as previously listed (76 FR 50447; August 15, 2011). The 2011 status reviews (NMFS 2011a, 2011b, 2011c) additionally stated that, although the listings should remain unchanged, the status of these populations have worsened over the past five years since the 2005/2006 reviews and recommended that status be reassessed in two to three years as opposed to waiting another five years.

2.2.1 Sacramento River Winter-run Chinook salmon

The Sacramento River winter-run Chinook salmon (winter-run *Oncorhynchus tshawytscha*) ESU, currently listed as endangered, was listed as a threatened species under emergency provisions of the ESA on August 4, 1989 (54 FR 32085) and formally listed as a threatened species in November 1990 (55 FR 46515). On January 4, 1994 (59 FR 440), NMFS re-classified winter-run as an endangered species. NMFS concluded that winter-run in the Sacramento River warranted listing as an endangered species due to several factors, including: (1) the continued decline and increased variability of run sizes since its first listing as a threatened species in 1989; (2) the expectation of weak returns in future years as the result of two small year classes (1991 and 1993); and (3) continued threats to the "take" of winter-run (August 15, 2011, 76 FR 50447).

On June 28, 2005, NMFS concluded that the winter-run ESU was "in danger of extinction" due to risks to the ESU's diversity and spatial structure and, therefore, continues to warrant listing as an endangered species under the ESA (70 FR 37160). In August 2011, NMFS completed a 5-year status review of five Pacific salmon ESUs, including the winter-run ESU, and again determined that the species' status should remain as "endangered" (August 15, 2011, 76 FR 50447). The 2011 review concluded that although the listing remained unchanged since the 2005 review, the status of the population had declined over the past five years (2005–2010).

The winter-run ESU currently consists of only one population that is confined to the upper Sacramento River (spawning downstream of Shasta and Keswick dams) in California's CV. In addition, an artificial propagation program at the Livingston Stone National Fish Hatchery (LSNFH) produces winter-run that are considered to be part of this ESU (June 28, 2005, 70 FR 37160). Most components of the winter-run life history (*e.g.*, spawning, incubation, freshwater rearing) have been compromised by the habitat blockage in the upper Sacramento River. All historical spawning and rearing habitats have been blocked since the construction of Shasta Dam in 1943. Remaining spawning and rearing areas are completely dependent on cold water releases from Shasta Dam in order to sustain the remnant population.

Life History

1. <u>Adult Migration and Spawning</u>

Winter-run exhibit a unique life history pattern (Healey 1994) compared to other salmon populations in the CV (*i.e.*, spring-run, fall-run, and late-fall run), in that they spawn in the summer, and the juveniles are the first to enter the ocean the following winter and spring. Adults first enter San Francisco Bay from November through June (Hallock and Fisher 1985) and migrate up the Sacramento River, past the RBDD from mid-December through early August (NMFS 1997). The majority of the run passes RBDD from January through May, with the peak passage occurring in mid-March (Hallock and Fisher 1985). The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type (Table 5; Yoshiyama *et al.* 1998, Moyle 2002).

Winter-run tend to enter freshwater while still immature and travel far upriver and delay spawning for weeks or months upon arrival at their spawning grounds (Healey 1991). Spawning occurs primarily from mid-May to mid-August, with the peak activity occurring in June and July in the upper Sacramento River reach (50 miles) between Keswick Dam and RBDD (Vogel and Marine 1991). Winter-run deposit and fertilize eggs in gravel beds known as redds excavated by the female that then dies following spawning. Average fecundity was 5,192 eggs/female for the 2006–2013 returns to LSNFH, which is similar to other Chinook salmon runs [*e.g.*, 5,401 average for Pacific Northwest (Quinn 2005)]. Chinook salmon spawning requirements for depth and velocities are broad, and the upper preferred water temperature is between 55–57°F (13–14°C) degrees (Snider *et al.* 2001). The majority of winter-run adults return after three years.

Table 5. The temporal occurrence of adult (a) and juvenile (b) winter-run in the Sacramento River. Darker shades indicate months of greatest relative abundance.

Winter run relative abundance	High				Medium				Low			
a) Adults freshwater												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River basin[a,b]												
Upper Sacramento River spawning[c]												
b) Juvenile emigration												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River at Red Bluff [d]												
Sacramento River at Knights Landing[e]												
Sacramento trawl at Sherwood Harbor[f]												
Midwater trawl at Chipps Island[g]												

Sources: [a] (Yoshiyama *et al*. 1998); (Moyle 2002); [b](Myers *et al.* 1998) ; [c] (Williams 2006) ; [d] (Martin *et al.* 2001); [e] Knights Landing Rotary Screw Trap Data, CDFW (1999-2011); [f,g] Delta Juvenile Fish Monitoring Program, USFWS (1995-2012)

2. Eggs/Fry Emergence

Winter-run incubating eggs are vulnerable to adverse effects from floods, flow fluctuations, siltation, desiccation, disease, predation during spawning, poor gravel percolation, and poor water quality. The optimal water temperature for egg incubation ranges from 46–56°F (7.8–13.3°C) and a significant reduction in egg viability occurs in mean daily water temperatures above 57.5°F (14.2°C; Seymour 1956, Boles 1988, USFWS 1998, EPA 2003, Richter and Kolmes 2005, Geist *et al.* 2006). Total embryo mortality can occur at temperatures above 62°F (16.7°C; NMFS 1997). Depending on ambient water temperature, embryos hatch within 40-60 days and alevin (yolk-sac fry) remain in the gravel beds for an additional 4–6 weeks. As their yolk-sacs become depleted, fry begin to emerge from the gravel and start exogenous feeding in their natal stream, typically in late July to early August and continuing through October (Fisher 1994).

3. Juvenile/Outmigration

Juvenile winter-run have been found to exhibit variability in their life history dependent on emergence timing and growth rates (Beckman *et al.* 2007). Following spawning, egg incubation, and fry emergence from the gravel, juveniles begin to emigrate in the fall. Some juvenile winter-run migrate to sea after only 4 to 7 months of river life, while others hold and rear upstream and spend 9 to 10 months in freshwater. Emigration of juvenile winter-run fry and pre-smolts past RBDD (RM 242) may begin as early as mid-July, but typically peaks at the end of September (Table 5), and can continue through March in dry years (Vogel and Marine 1991, NMFS 1997).

4. Estuarine/Delta Rearing

Juvenile winter-run emigration into the estuary/Delta occurs primarily from November through early May based on data collected from trawls in the Sacramento River at Sherwood Harbor (West Sacramento), RM 57 (USFWS 2001). The timing of emigration may vary somewhat due to changes in river flows, Shasta Dam operations, and water year type, but has been correlated with the first storm event when flows exceed 14,000 cfs at Knights Landing, RM 90, which trigger abrupt emigration towards the Delta (del Rosario *et al.* 2013). Residence time in the Delta for juvenile winter-run averages approximately 3 months based on median seasonal catch between Knights Landing and Chipps Island. In general, the earlier juvenile winter-run arrive in the Delta, the longer they stay and rear, as peak departure at Chipps Island regularly occurs in March (del Rosario *et al.* 2013). The Delta serves as an important rearing and transition zone for juvenile winter-run as they feed and physiologically adapt to marine waters (smoltification). The majority of juvenile winter-run in the Delta are 104 to 128 millimeters (mm) in size based on USFWS trawl data (1995-2012), and from 5 to 10 months of age, by the time they depart the Delta (Fisher 1994, Myers *et al.* 1998).

5. Ocean Rearing

Winter-run smolts enter the Pacific Ocean mainly in spring (March–April), and grow rapidly on a diet of small fishes, crustaceans, and squid. Salmon runs that migrate to sea at a larger size tend to have higher marine survival rates (Quinn 2005). The diet composition of Chinook salmon from California consist of anchovy, rockfish, herring, and other invertebrates (in order of preference, Healey 1991). Most Chinook from the Central Valley move northward into Oregon and Washington, where herring make up the majority of their diet. However winter-run, upon entering the ocean, tend to stay near the California coast and distribute from Point Arena southward to Monterey Bay. Winter-run have high metabolic rates, feed heavily, and grow fast, compared to other fishes in their range. They can double their length and increase their weight more than ten-fold in the first summer at sea (Quinn 2005). Mortality is typically highest in the first summer at sea, but can depend on ocean conditions. Winter-run abundance has been correlated with ocean conditions, such as periods of strong up-welling, cooler temperatures, and El Nino events (Lindley *et al.* 2009). Winter-run spend approximately 1-2 years rearing in the ocean before returning to the Sacramento River as 2-3 year old adults. Very few winter-run Chinook salmon reach age 4. Once they reach age 3, they are large enough to become vulnerable to commercial and sport fisheries.

Description of Viable Salmonid Population (VSP) Parameters

1. Abundance

Historically, winter-run population estimates were as high as 120,000 fish in the 1960s, but declined to less than 200 fish by the 1990s (NMFS 2011). In recent years, since carcass surveys began in 2001 (Figure 3), the highest adult escapement occurred in 2005 and 2006 with 15,839 and 17,296, respectively. However, from 2007 to 2012, the population has shown a precipitous decline, averaging 2,486 during this period, with a low of 827 adults in 2011 (Figure 3). This recent declining trend is likely due to a combination of factors such as poor ocean productivity (Lindley *et al.* 2009), drought conditions from 2007-2009, and low in-river survival (NMFS 2011a). In 2013, the population increased to 6,075 adults, well above the 2007–2012 average, but below the high for the last ten years.

Although impacts from hatchery fish (*i.e.*, reduced fitness, weaker genetics, smaller size, less ability to avoid predators) are often cited as having deleterious impacts on natural in-river populations (Matala *et al.* 2012), the winter-run conservation program at LSNFH is strictly controlled by the USFWS to reduce such impacts. The average annual hatchery production at LSNFH is approximately 176,348 per year (2001–2010 average) compared to the estimated natural production that passes RBDD, approximately 4.7 million (2002–2010 average, Poytress and Carrillo 2011). Therefore, hatchery production typically represents approximately 3-4 percent of the total in-river juvenile production in any given year.

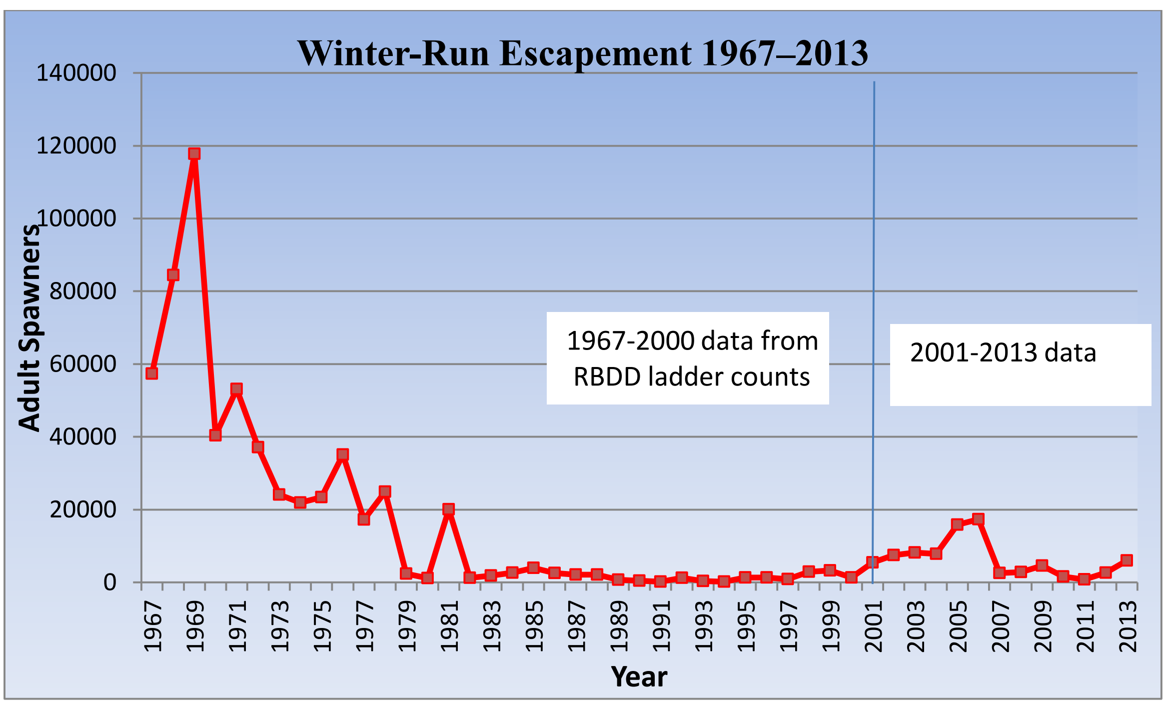

Figure 3. Winter-run Chinook salmon escapement numbers 1970-2013, includes hatchery broodstock and tributaries, but excludes sport catch. RBDD ladder counts used pre-2000, carcass surveys post 2001 (3).

2. Productivity

ESU productivity was positive over the period 1998–2006, and adult escapement and juvenile production had been increasing annually until 2007, when productivity became negative (Figure 4) with declining escapement estimates. The long-term trend for the ESU, therefore, remains negative, as the productivity is subject to impacts from environmental and artificial conditions. The population growth rate based on cohort replacement rate (CRR) for the period 2007–2012 suggests a reduction in productivity (Figure 4), and indicates that the winter-run population is not replacing itself. In 2013, winter-run experienced a positive CRR, possibly due to favorable in-river conditions in 2011 (a wet year), which increased juvenile survival to the ocean.

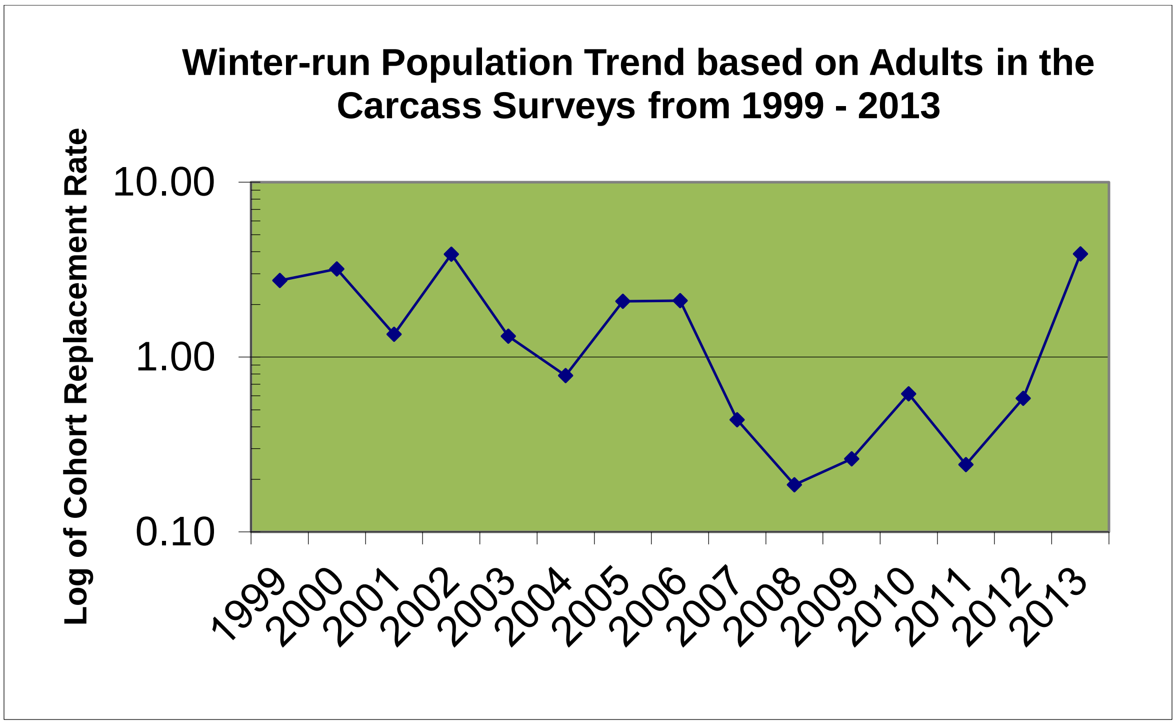

Figure 4. Winter-run population trend using cohort replacement rate derived from adult escapement, including hatchery fish, 1986–2013.

An age-structured density-independent model of spawning escapement by Botsford and Brittnacher (1998) assessing the viability of winter-run found the species was certain to fall below the quasi-extinction threshold of three consecutive spawning runs with fewer than 50 females (Good *et al.* 2005). Lindley and Mohr (2003) assessed the viability of the population using a Bayesian model based on spawning escapement that allowed for density dependence and a change in population growth rate in response to conservation measures found a biologically significant expected quasi-extinction probability of 28 percent. Although the growth rate for the winter-run population improved up until 2006, it exhibits the typical variability found in most endangered species populations. The fact that there is only one population, dependent upon cold-water releases from Shasta Dam, makes it vulnerable to periods of prolonged drought (NMFS 2011). Productivity, as measured by the number of juveniles entering the Delta, or juvenile production estimate (JPE), has declined in recent years from a high of 3.8 million in 2007 to 1.1

million in 2013 (Table 6). Due to uncertainties in the various factors, the JPE was updated in 2010 with the addition of confidence intervals (Cramer Fish Sciences model), and again in 2013 with a change in survival based on acoustic tag data (NMFS 2014). However, juvenile winter-run productivity is still much lower than other Chinook salmon runs in the Central Valley and in the Pacific Northwest (Michel 2010).

Table 6. Winter-run adult and juvenile population estimates based on RBDD counts (1986–2001) and carcass counts (2001–2013), with corresponding 3-year-cohort replacement rates.

Return Year	Adult Population Estimate[a]	Cohort Replacement Rate[b]	NMFS-calculated Juvenile Production
1986	2596		
1987	2185		
1988	2878		
1989	696	0.27	
1990	430	0.20	
1991	211	0.07	
1992	1240	1.78	40,100
1993	387	0.90	273,100
1994	186	0.88	90,500
1995	1297	1.05	74,500
1996	1337	3.45	338,107
1997	880	4.73	165,069
1998	2992	2.31	138,316
1999	3288	2.46	454,792
2000	1352	1.54	289,724
2001	8224	2.75	370,221
2002	7441	2.26	1,864,802
2003	8218	6.08	2,136,747
2004	7869	0.96	1,896,649
2005	15839	2.13	881,719
2006	17296	2.10	3,556,995
2007	2542	0.32	3,890,534
2008	2830	0.18	1,100,067
2009	4537	0.26	1,152,043
2010	1,596	0.63	1,144,860
2011	827	0.29	332,012
2012	2,674	0.59	162,051
2013	6,075	3.88	1,196,387
median	2,542	0.95	412,507

[a] Population estimates include adults taken into the hatchery and were based on ladder counts at RBDD until 2001, after which the methodology changed to carcass surveys (CDFG 2012).

[b] Assumes all adults return after three years. NMFS calculated a CRR using the adult spawning population, divided by the spawning population three years prior. Two year old returns were not used.

[c] JPE estimates include survival estimates from the spawning gravel to the point where they enter the Delta (Sacramento I St Bridge), but does not include through-Delta survival.

3. Spatial Structure

The distribution of winter-run spawning and initial rearing historically was limited to the upper Sacramento River (upstream of Shasta Dam), McCloud River, Pitt River, and Battle Creek, where springs provided cold water throughout the summer, allowing for spawning, egg incubation, and rearing during the mid-summer period (Slater 1963 *op. cit.* Yoshiyama et al. 1998). The construction of Shasta Dam in 1943 blocked access to all of these waters except Battle Creek, which currently has its own impediments to upstream migration (*i.e.*, a number of small hydroelectric dams situated upstream of the Coleman Fish Hatchery weir). The Battle Creek Salmon and Steelhead Restoration Project (BCSSRP) is currently removing these impediments, which should restore spawning and rearing habitat for winter-run in the future. Approximately 299 miles of former tributary spawning habitat upstream of Shasta Dam is inaccessible to winter-run. Yoshiyama *et al.* (2001) estimated that in 1938, the upper Sacramento River had a "potential spawning capacity" of approximately 14,000 redds equal to 28,000 spawners. Since 2001, the majority of winter-run redds have occurred in the first 10 miles downstream of Keswick Dam. Most components of the winter-run life history (*e.g.*, spawning, incubation, freshwater rearing) have been compromised by the construction of Shasta Dam.

The greatest risk factor for winter-run lies within its spatial structure (NMFS 2011). The remnant and remaining population cannot access 95% of their historical spawning habitat, and must therefore be artificially maintained in the Sacramento River by: (1) spawning gravel augmentation, (2) hatchery supplementation, and, (3) regulating the finite cold-water pool behind Shasta Dam to reduce water temperatures. Winter-run require cold water temperatures in the summer that simulate their upper basin habitat, and they are more likely to be exposed to the impacts of drought in a lower basin environment. Battle Creek is currently the most feasible opportunity for the ESU to expand its spatial structure, but restoration is not scheduled to be completed until 2017 (BCSSRP). The draft CV Salmon and Steelhead Recovery Plan includes criteria for recovering the winter-run Chinook salmon ESU, including re-establishing a population into historical habitats upstream of Shasta Dam (NMFS 2009b). Additionally, NMFS (2009a) included a requirement for a pilot fish passage program upstream of Shasta Dam.

4. Diversity

The current winter-run population is the result of the introgression of several stocks (*e.g.,* spring-run and fall-run Chinook) that occurred when Shasta Dam blocked access to the upper watershed. A second genetic bottleneck occurred with the construction of Keswick Dam which blocked access and did not allow spatial separation of the different runs (Good *et al.* 2005). Lindley *et al.* (2007) recommended reclassifying the winter-run population extinction risk from low to moderate, if the proportion of hatchery origin fish from the LSNFH exceeded 15 percent due to the impacts of hatchery fish over multiple generations of spawners. Since 2005, the percentage of hatchery winter-run recovered in the Sacramento River has only been above 15 percent in two years, 2005 and 2012 (Figure 5).
Concern over genetic introgression within the winter-run population led to a conservation

program at LSNFH that encompasses best management practices such as: (1) genetic confirmation of each adult prior to spawning, (2) a limited number of spawners based on the effective population size, and (3) use of only natural-origin spawners since 2009. These practices reduce the risk of hatchery impacts on the wild population. Hatchery-origin winter-run have made up more than 5 percent of the natural spawning run in recent years and in 2012, it exceeded 30 percent of the natural run (Figure 5). However, the average over the last 16 years (approximately 5 generations) has been 8 percent, still below the low-risk threshold (15%) used for hatchery influence (Lindley *et al.* 2007).

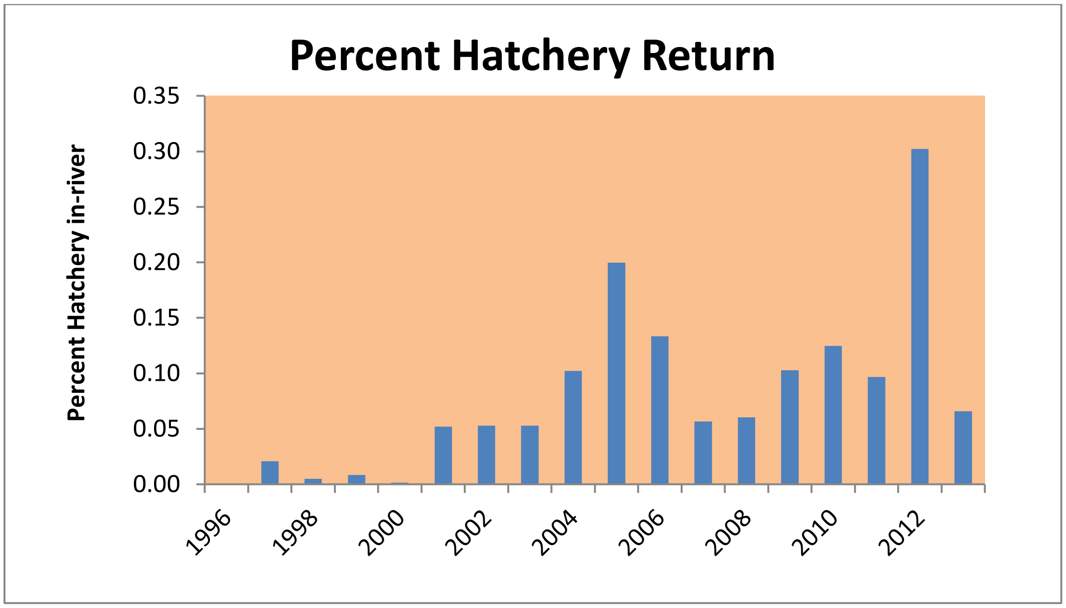

Figure 5. Percentage of hatchery-origin winter-run Chinook salmon naturally spawning in the Sacramento River (1996–2013). Source: CDFW carcass surveys, 2013.

Summary of Sacramento River Winter-run Chinook Salomon ESU Viability

There are several criteria (only one is required) that would qualify the winter-run ESU at moderate risk of extinction, and since there is still only one population that spawns downstream of Keswick Dam, that population would be at high risk of extinction in the long-term according the criteria in Lindley *et al.* (2007). Recent trends in those criteria are: (1) continued low abundance (Figure 3); (2) a negative growth rate over 6 years (2006–2012), which is two complete generations (Figure 4); (3) a significant rate of decline since 2006; and (4) increased risk of catastrophe from oil spills, wild fires, or extended drought (climate change). The most recent 5-year status review (NMFS 2011) on winter-run concluded that the ESU had increased to a high risk of extinction. In summary, the most recent biological information suggests that the extinction risk for the winter-run ESU has increased from moderate risk to high risk of extinction since 2005, and that several listing factors have contributed to the recent decline, including drought and poor ocean conditions (NMFS 2011).

Critical Habitat: Essential Features for Sacramento River Winter-run Chinook Salmon

NMFS designated critical habitat for winter-run Chinook salmon on June 16, 1993 (58 FR 33212). Critical habitat was delineated as the Sacramento River from Keswick Dam at river mile (RM) 302 to Chipps Island, RM 0, at the westward margin of the Sacramento-San Joaquin Delta (Delta), including Kimball Island, Winter Island, and Brown's Island; all waters from Chipps Island westward to the Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay north of the San Francisco-Oakland Bay Bridge from San Pablo Bay to the Golden Gate Bridge. In the Sacramento River, critical habitat includes the river water, river bottom, and the adjacent riparian zone.

Critical habitat for winter-run is defined as specific areas (listed below) that contain the physical and biological features considered essential to the conservation of the species. This designation includes the river water, river bottom (including those areas and associated gravel used by winter-run as spawning substrate), and adjacent riparian zone used by fry and juveniles for rearing (June 16, 1993, 58 FR 33212). NMFS limits "adjacent riparian zones" to only those areas above a stream bank that provide cover and shade to the near shore aquatic areas. Although the bypasses (*e.g.,* Yolo, Sutter, and Colusa) are not currently designated critical habitat for winter-run, NMFS recognizes that they may be utilized when inundated with Sacramento River flood flows and are important rearing habitats for juvenile winter-run. Also, juvenile winter-run may use tributaries of the Sacramento River for non-natal rearing. Critical habitat also includes the estuarine water column and essential foraging habitat and food resources used by winter-run as part of their juvenile outmigration or adult spawning migration.

The following is the status of the physical and biological habitat features that are considered to be essential for the conservation of winter-run (June 16, 1993, 58 FR 33212):

1. Access from the Pacific Ocean to Appropriate Spawning Areas

Adult migration corridors should provide satisfactory water quality, water quantity, water temperature, water velocity, cover, shelter and safe passage conditions in order for adults to reach spawning areas. Adult winter-run generally migrate to spawning areas during the winter and spring. At that time of year, the migration route is accessible to the appropriate spawning grounds on the upper 60 miles of the Sacramento River, however much of this migratory habitat is degraded and they must pass through a fish ladder at the Anderson-Cottonwood Irrigation Dam (ACID). In addition, the many flood bypasses are known to strand adults in agricultural drains due to inadequate screening (Vincik and Johnson 2013). Since the primary migration corridors are essential for connecting early rearing habitat with the ocean, even the degraded reaches are considered to have a high intrinsic conservation value to the species.

2. The Availability of Clean Gravel for Spawning Substrate

Suitable spawning habitat for winter-run exists in the upper 60 miles of the Sacramento River between Keswick Dam and Red Bluff Diversion Dam (RBDD). However, the majority of spawning habitat currently being used occurs in the first 10 miles downstream of Keswick Dam.

The available spawning habit is completely outside the historical range utilized by winter-run upstream of Keswick Dam. Because Shasta and Keswick dams block gravel recruitment, the U.S. Bureau of Reclamation (Reclamation) annually injects spawning gravel into various areas of the upper Sacramento River. With the supplemented gravel injections, the upper Sacramento River reach continues to support a small naturally-spawning winter-run Chinook salmon population. Even in degraded reaches, spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of listed salmonids.

3. <u>Adequate River Flows for Successful Spawning, Incubation of Eggs, Fry Development and Emergence, and Downstream Transport of Juveniles</u>

An April 5, 1960, Memorandum of Agreement between Reclamation and the CDFW originally established flow objectives in the Sacramento River for the protection and preservation of fish and wildlife resources. In addition, Reclamation complies with the 1990 flow releases required in State Water Resource Control Board (SWRCB) Water Rights Order (WRO) 90-05 for the protection of Chinook salmon. This order includes a minimum flow release of 3,250 cubic feet per second (cfs) from Keswick Dam downstream to RBDD from September through February during all water year types, except critically dry.

4. <u>Water Temperatures at 5.8–14.1°C (42.5–57.5°F) for Successful Spawning, Egg Incubation, and Fry Development</u>

Summer flow releases from Shasta Reservoir for agriculture and other consumptive uses drive operations of Shasta and Keswick dam water releases during the period of winter-run migration, spawning, egg incubation, fry development, and emergence. This pattern, the opposite of the pre-dam hydrograph, benefits winter-run by providing cold water for miles downstream during the hottest part of the year. The extent to which winter-run habitat needs are met depends on Reclamation's other operational commitments, including those to water contractors, Delta requirements pursuant to State Water Rights Decision 1641 (D-1641), and Shasta Reservoir end of September storage levels required in the NMFS 2009 biological opinion on the long-term operations of the CV Project and State Water Project (CVP/SWP, NMFS 2009a). WRO 90-05 and 91-1 require Reclamation to operate Shasta, Keswick, and Spring Creek Powerhouse to meet a daily average water temperature of 13.3°C (56°F) at RBDD. They also provide the exception that the water temperature compliance point (TCP) may be modified when the objective cannot be met at RBDD. Based on these requirements, Reclamation models monthly forecasts and determines how far downstream 13.3°C (56°F) can be maintained throughout the winter-run spawning, egg incubation, and fry development stages.

In every year since WRO 90-05 and 91-1were issued, operation plans have included modifying the TCP to make the best use of the cold water available based on water temperature modeling and current spawning distribution. Once a TCP has been identified and established in May, it generally does not change, and therefore, water temperatures are typically adequate through the summer for successful winter-run egg incubation and fry development for those redds constructed upstream of the TCP (except for in some critically dry and drought years). However, by continually moving the TCP upstream, the value of that habitat is degraded by reducing the spawning area in size and imprinting upon the next generation to return further upstream.

5. Habitat and Adequate Prey Free of Contaminants

Water quality conditions have improved since the 1980s due to stricter standards and Environmental Protection Agency (EPA) Superfund site cleanups (see Iron Mountain Mine remediation under Factors). No longer are there fish kills in the Sacramento River caused by the heavy metals (*e.g.,* lead, zinc and copper) found in the Spring Creek runoff. However, legacy contaminants such as mercury (and methyl mercury), polychlorinated biphenyls (PCB), heavy metals and persistent organochlorine pesticides continue to be found in watersheds throughout the CV. In 2010, the EPA, listed the Sacramento River as impaired under the Clean Water Act, section 303(d), due to high levels of pesticides, herbicides, and heavy metals (http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/category5_report.shtml). Although most of these contaminants are at low concentrations in the food chain, they continue to work their way into the base of the food web, particularly when sediments are disturbed and previously entombed compounds are released into the water column.

Adequate prey for juvenile salmon to survive and grow consists of abundant aquatic and terrestrial invertebrates that make up the majority of their diet before entering the ocean. Exposure to these contaminated food sources such as invertebrates may create delayed sublethal effects that reduce fitness and survival (Laetz *et al*. 2009). Contaminants are typically associated with areas of urban development, agriculture, or other anthropogenic activities (*e.g.*, mercury contamination as a result of gold mining or processing). Areas with low human impacts frequently have low contaminant burdens, and therefore lower levels of potentially harmful toxicants in the aquatic system. Freshwater rearing habitat has a high intrinsic conservation value even if the current conditions are significantly degraded from their natural state.

6. Riparian and Floodplain Habitat that Provides for Successful Juvenile Development and Survival

The channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento River system typically have low habitat complexity, low abundance of food organisms, and offer little protection from predators. Juvenile life stages of salmonids are dependent on the natural functioning of this habitat for successful survival and recruitment. Ideal habitat contains natural cover, such as riparian canopy structure, submerged and overhanging large woody material (LWM), aquatic vegetation, large rocks and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Riparian recruitment is prevented from becoming established due to the reversed hydrology (*i.e*., high summer time flows and low winter flows prevent tree seedlings from establishing). However, there are some complex, productive habitats within historical floodplains [*e.g*., Sacramento River reaches with setback levees (*i.e*., primarily located upstream of the City of Colusa)] and flood bypasses (*i.e.*, fish in Yolo and Sutter bypasses experience rapid growth and higher survival due to abundant food resources) seasonally available that remain in the system. Nevertheless, the current condition of degraded riparian habitat along the mainstem Sacramento River restricts juvenile growth and survival (Michel 2010, Michel *et al.* 2012).

7. Access Downstream so that Juveniles Can Migrate from the Spawning Grounds to San Francisco Bay and the Pacific Ocean

Freshwater emigration corridors should be free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. Migratory corridors are downstream of the Keswick Dam spawning areas and include the mainstem of the Sacramento River to the Delta, as well as non-natal rearing areas near the confluence of some tributary streams.

Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. Unscreened diversions that entrain juvenile salmonids are prevalent throughout the mainstem Sacramento River and in the Delta. Predators such as striped bass (*Morone saxatilis*) and Sacramento pikeminnow (*Ptychocheilus grandis*) tend to concentrate immediately downstream of diversions, resulting in increased mortality of juvenile Chinook salmon.

Water pumping at the CVP/SWP export facilities in the South Delta at times causes the flow in the river to move back upstream (reverse flow), further disrupting the emigration of juvenile winter-run by attracting and diverting them to the interior Delta, where they are exposed to increased rates of predation, other stressors in the Delta, and entrainment at pumping stations. NMFS' biological opinion on the long-term operations of the CVP/SWP (NMFS 2009a) sets limits to the strength of reverse flows in the Old and Middle Rivers, thereby keeping salmon away from areas of highest mortality. Regardless of the condition, the remaining estuarine areas are of high conservation value because they provide factors which function as rearing habitat and as an area of transition to the ocean environment.

2.2.2 Central Valley Spring-run Chinook salmon

In August 2011, NMFS completed an updated status review of five Pacific Salmon ESUs, including CV spring-run Chinook salmon, and concluded that the species' status should remain as previously listed (76 FR 50447). The 2011 Status Review (NMFS 2011b) additionally stated that although the listings will remain unchanged since the 2005 review, and the original 1999 listing (64 FR 50394), the status of these populations has worsened over the past five years and recommended that the status be reassessed in two to three years as opposed to waiting another five years.

CV spring-run Chinook salmon were listed as threatened on September 16, 1999, (64 FR 50394). This ESU consists of spring-run Chinook salmon occurring in the Sacramento River basin. The Feather River Fish Hatchery (FRFH) spring-run Chinook salmon population has been included as part of the CV spring-run Chinook salmon ESU in the most recent modification of the CV spring-run Chinook salmon listing status (70 FR 37160). Critical habitat was designated for CV spring-run Chinook salmon on September 2, 2005, (70 FR 52488), and includes the action area for the Proposed Action. It includes stream reaches of the Feather and Yuba rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the main stem of the Sacramento River from Keswick Dam through the Delta; and portions of the network of channels in the northern Delta.

Historically spring-run Chinook salmon were the second most abundant salmon run in the CV and one of the largest on the west coast (CDFG 1990, 1998). These fish occupied the upper and middle reaches (1,000 to 6,000 feet elevation) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit rivers, with smaller populations in most tributaries with sufficient habitat for over-summering adults (Stone 1874, Rutter 1904, Clark 1929). The CV Technical Review Team (TRT) estimated that historically there were 18 or 19 independent populations of CV spring-run Chinook salmon, along with a number of dependent populations, all within four distinct geographic regions (diversity groups) (Lindley *et al.* 2004). Of these 18 populations, only 3 extant populations currently exist (Mill, Deer, and Butte creeks on the upper Sacramento River) and they represent only the northern Sierra Nevada diversity group. All populations in the basalt and porous lava diversity group and the southern Sierra Nevada diversity group have been extirpated. The northwestern California diversity group did not historically contain independent populations, and currently contains two or three populations that are likely dependent on the northern Sierra Nevada diversity group populations for their continued existence.

Construction of low elevation dams in the foothills of the Sierras on the Mokelumne, Stanislaus, Tuolumne, and Merced rivers, was thought to have extirpated CV spring-run Chinook salmon from these watersheds of the San Joaquin River, as well as on the American and Yuba rivers of the Sacramento River basin. However, observations in the last decade suggest that perhaps a naturally occurring population may still persist in the Stanislaus and Tuolumne rivers (Franks, personal communication, 2012), as well as in the Yuba River. Documented naturally-spawning populations of CV spring-run Chinook salmon are currently restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and the Yuba River (CDFG 1998).

Life History

Adult CV spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February (CDFG 1998) and enter the Sacramento River beginning in March (Yoshiyama 1998). Spring-run Chinook salmon move into tributaries of the Sacramento River (*e.g.* Butte, Mill, Deer creeks) beginning as early as February in Butte Creek and typically mid-March in Mill and Deer creeks (Lindley *et al.* 2004). Adult migration peaks around mid-April in Butte Creek, and mid-to end of May in Mill and Deer creeks, and is complete by the end of July in all three tributaries (Lindley *et al.* 2004) (Table 7). Typically, spring-run Chinook salmon utilize mid- to high-elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering while conserving energy and allowing their gonadal tissue to mature (Yoshiyama *et al.* 1998).

Spring-run Chinook salmon spawning occurs between September and October (Moyle 2002). Between 56 and 87 percent of adult spring-run Chinook salmon that enter the Sacramento River basin to spawn are 3 years old (Calkins *et al.* 1940, Fisher 1994).

Spring-run Chinook salmon fry emerge from the gravel from November to March (Moyle 2002) and the emigration timing is highly variable, as they may migrate downstream as young-of-the-year or as juveniles or yearlings. The model size of fry migrants at approximately 40 millimeters (mm) between December and April in Mill, Butte, and Deer creeks reflects a prolonged emergence of fry from the gravel (Lindley *et al.* 2004). Studies in Butte Creek, (Ward *et al.* 2003, McReynolds *et al.* 2007) found the majority of CV spring-run Chinook salmon migrants to be fry, which occurred primarily during December, January, and February; and that these movements appeared to be influenced by increased flow. Small numbers of CV spring-run Chinook salmon were observed to remain in Butte Creek to rear and migrated as yearlings later in the spring. Juvenile emigration patterns in Mill and Deer creeks are very similar to patterns observed in Butte Creek, with the exception that Mill and Deer creek juveniles typically exhibit a later young-of-the-year migration and an earlier yearling migration (Lindley *et al.* 2004). CDFW (CDFG 1998) observed the emigration period for spring-run Chinook salmon extending from November to early May, with up to 69 percent of the young-of-the-year fish outmigrating through the lower Sacramento River and Delta during this period. Peak movement of juvenile CV spring-run Chinook salmon in the Sacramento River at Knights Landing occurs in December, and again in March and April. However, juveniles also are observed between November and the end of May (Snider and Titus 2000).

Once juveniles emerge from the gravel they initially seek areas of shallow water and low velocities while they finish absorbing the yolk sac and transition to exogenous feeding (Moyle 2002). Many also would disperse downstream during high-flow events. As is the case in other salmonids, there is a shift in microhabitat use by juveniles to deeper faster water as they grow larger. Microhabitat use can be influenced by the presence of predators which can force fish to select areas of heavy cover and suppress foraging in open areas (Moyle 2002).

Table 7. The temporal occurrence of adult (a) and juvenile (b) CV spring-run Chinook salmon in the Sacramento River. Darker shades indicate months of greatest relative abundance.

(a) Adult migration												
Location	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Sac.River basin[a,b]												
Sac. River mainstem[c]												
Mill Creek[d]												
Deer Creek[d]												
Butte Creek[d]												
(b) Adult Holding												
(c) Adult Spawning												
(d) Juvenile migration												
Location	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Sac. River Tribs[e]												
Upper Butte Creek[f]												
Mill, Deer, Butte Creeks[d]												
Sac. River at RBDD[c]												
Sac. River at KL[g]												

Relative Abundance: ■ = High ■ = Medium ■ = Low

Note: Yearling spring-run Chinook salmon rear in their natal streams through the first summer following their birth. Downstream emigration generally occurs the following fall and winter. Most young of the year spring-run Chinook salmon emigrate during the first spring after they hatch.

Sources: [a]Yoshiyama *et al.* (1998); [b]Moyle (2002); [c]Myers *et al.* (1998); [d]Lindley *et al.* (2004); [e]CDFG (1998); [f]McReynolds *et al.* (2007); Ward *et al.* (2003); [g]Snider and Titus (2000)

Description of VSP Parameters

Like the winter-run Chinook salmon population, the CV spring-run Chinook salmon population fails to meet the "representation and redundancy rule" since there are only one demonstrably viable populations in one diversity group (northern Sierra Nevada) out of the three diversity groups that historically contained them. Over the long term, these remaining populations are considered to be vulnerable to catastrophic events, such as volcanic eruptions from Mount

Lassen or large forest fires due to the close proximity of their headwaters to each other. Drought is also considered to pose a significant threat to the viability of the spring-run Chinook salmon populations in these three watersheds due to their close proximity to each other.

1. Abundance

The CV drainage as a whole is estimated to have supported spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (CDFG 1998). The San Joaquin River historically supported large runs of spring-run Chinook salmon, suggested to be one of the largest runs of any Chinook salmon on the West Coast with estimates averaging 200,000 – 500,000 adults returning annually (CDFG 1990). Construction of Friant Dam began in 1939 and was completed in 1942, which blocked access to upstream habitat.

The FRFH spring-run Chinook salmon population has been included in the ESU based on its genetic linkage to the natural population and the potential development of a conservation strategy for the hatchery program. On the Feather River, significant numbers of spring-run Chinook salmon, as identified by run timing, return to the FRFH. Since 1954, spawning escapement has been estimated using combinations of in-river estimates and hatchery counts, with estimates ranging from 2,908 in 1964 to 2 fish in 1978 (DWR 2001). Spring-run estimates after 1981 have been based solely on salmon entering the hatchery during the month of September. The 5-year moving averages from 1997 to 2006 had been more than 4,000 fish, but from 2007 to 2011, the 5-year moving averages have declined each year to a low of 1,783 fish in 2011 (CDFG 2012). However, coded wire tag (CWT) information from these hatchery returns has indicated that fall-run and spring-run Chinook salmon have overlap (DWR 2001). In addition, genetic testing has indicated substantial introgression has occurred between fall-run and spring-run Chinook salmon populations within the Feather River system due to temporal overlap and hatchery practices (DWR 2001). Because Chinook salmon have not always been spatially separated in the FRFH, spring-run and fall-run Chinook salmon have been spawned together, thus compromising the genetic integrity of the spring-run Chinook salmon stock (Good *et al.* 2005; DWR draft Hatchery Genetic Management Plan 2010). For the reasons discussed above, the Feather River spring-run Chinook salmon population numbers are not included in the following discussion of ESU abundance.

In addition, monitoring of the Sacramento River mainstem during spring-run Chinook salmon spawning timing indicates some spawning occurs in the river. Here, the lack of physical separation of spring-run Chinook salmon from fall-run Chinook salmon is complicated by overlapping migration and spawning periods. Significant hybridization with fall-run Chinook salmon makes identification of spring-run Chinook salmon in the mainstem very difficult to determine, but counts of early spawning Chinook salmon redds are typically used as an indicator of abundance. Less than 15 redds per year were observed in the Sacramento River from 1989 to 1993, during September aerial redd counts (USFWS 2003). Redd surveys conducted in September between 2001 and 2011 have observed an average of 36 salmon redds from Keswick Dam downstream to the RBDD, ranging from three to 105 redds (CDFG, unpublished data, 2011). Therefore, even though physical habitat conditions can support spawning and incubation, spring-run Chinook salmon depend on spatial segregation and geographic isolation from fall-run Chinook salmon to maintain genetic diversity. With the onset of fall-run Chinook salmon spawning occurring in the same time and place as potential spring-run Chinook salmon spawning, it is likely to have caused extensive introgression between the populations (CDFG 1998). For these reasons, Sacramento River mainstem spring-run Chinook salmon are not included in the following discussion of ESU abundance trends.

Sacramento River tributary populations in Mill, Deer, and Butte creeks are likely the best trend indicators for the CV spring-run Chinook salmon ESU as a whole because these streams contain the primary independent populations within the ESU. Generally, these streams have shown a positive escapement trend since 1991, displaying broad fluctuations in adult abundance, ranging from 1,013 in 1993 to 23,788 in 1998. Tributary numbers during 2005 to 2011 showed a downturn; however, 2012 and 2013 showed an increase to 10,810 and 18,499 fish, respectively. Escapement numbers for 2013 increased in most tributary populations, which resulted in the second highest number of spring-run Chinook salmon returning to the tributaries since 1960. Escapement numbers are dominated by Butte Creek returns, which have averaged over 7,000 fish from 1995 to 2005. During this same period, adult returns on Mill and Deer creeks have averaged 780 fish, and 1,464 fish respectively. From 2001 to 2005, the CV spring-run Chinook salmon ESU has experienced a trend of increasing abundance in some natural populations, most dramatically in the Butte Creek population (Good *et al.* 2005). Although trends were generally positive during this time, annual abundance estimates display a high level of fluctuation, and the overall number of CV spring-run Chinook salmon remains well below estimates of historic abundance.

In 2002 and 2003, mean water temperatures in Butte Creek exceeded 21ºC for 10 or more days in July (Williams 2006). These persistent high water temperatures, coupled with high fish densities, precipitated an outbreak of Columnaris Disease (*Flexibacter columnaris*) and Ichthyophthiriasis (*Ichthyophthirius multifiis*) in the adult spring-run Chinook salmon over-summering in Butte Creek. In 2002, this contributed to the pre-spawning mortality of approximately 20 to 30 percent of the adults. In 2003, approximately 65 percent of the adults succumbed, resulting in a loss of an estimated 11,231 adult spring-run Chinook salmon in Butte Creek due to the disease. Since 2005, abundance numbers in most of the tributaries have declined. From 2006 to 2009, adult returns indicate that population abundance is declining from the peaks seen in the 5 years prior for the entire Sacramento River basin.

For Mill Creek the 2009, return of 220 spring-run Chinook salmon was the lowest return since 1997. Assuming the 2012, spring-run Chinook salmon return was primarily of three year old fish, then those 768 Chinook salmon represent a significant increase over the 2009, parent year. The 2013 estimate was 644, which was an increase from 2010 estimate of 482. The Mill Creek population of spring-run Chinook salmon is currently at a moderate risk of extinction, due to the significant decline in abundance from prior to 2008 through 2011. However, with the increase in abundance in 2012 and 2013, this trend may be improving. The Deer Creek abundance of spring-run Chinook salmon experienced a significant decline starting in 2008, with an increase in 2012 and 2013.

The abundance of spring-run Chinook salmon in Clear Creek was lower in 2010, 2011, and from 2005 through 2011, abundance numbers in most of the tributaries declined. Adult returns from 2006 to 2009, indicate that population abundance for the entire Sacramento River basin was declining from the peaks seen in the five years prior to 2006. Declines in abundance from 2005 to 2011, placed the Mill Creek and Deer Creek populations in the high extinction risk category due to the rates of decline, and in the case of Deer Creek, also the level of escapement (NMFS 2011). Butte Creek had sufficient abundance to retain its low extinction risk classification, but the rate of population decline in years 2006 through 2011 was nearly sufficient to classify it as a high extinction risk based on this criteria. Nonetheless, the watersheds identified as having the highest likelihood of success for achieving viability/low risk of extinction include, Butte, Deer and Mill creeks (NMFS 2011). Some other tributaries to the Sacramento River, such as Clear Creek and Battle Creek have seen population gains in the years from 2001 to 2009, but the overall abundance numbers have remained low. Year 2012 appeared to be a good return year for most of the tributaries with some, such as Battle Creek, having the highest return on record (799). Additionally, 2013 adult escapement numbers combined for Butte, Mill and Deer creeks increased (over 17,000), which resulted in the second highest number of spring-run Chinook salmon returning to the tributaries since 1998. 2014 adult escapement was lower than 2013 to be lower, with an adult escapement of just over 5,000 fish, which indicates a highly fluctuating and unstable ESU.

1. Productivity

The 5-year geometric mean for the extant Butte, Deer, and Mill creek spring-run Chinook salmon populations ranged from 491 to 4,513 fish, indicating increasing productivity over the short-term and was projected to likely continue into the future (Good *et al.* 2005). However, as mentioned in the previous paragraph, the next five years of adult escapement to these tributaries has seen a cumulative decline in fish numbers and the CRR has declined in concert with the population declines. The productivity of the Feather River and Yuba River populations and contribution to the CV spring-run ESU currently is unknown.

2. Spatial Structure

With only one of four diversity groups currently containing viable populations, the spatial structure of CV spring-run Chinook salmon is severely reduced. Butte Creek spring-run Chinook salmon cohorts have recently utilized all currently available habitat in the creek; and it is unknown if individuals have opportunistically migrated to other systems. The persistent populations in Clear Creek and Battle Creek, with habitat restoration completed and underway are anticipated to add to the spatial structure of the CV spring-run Chinook salmon ESU if they can reach viable status in the basalt and porous lava and northwestern California diversity group areas. The spatial structure of the spring-run Chinook salmon ESU would still be lacking with the extirpation of all San Joaquin River basin spring-run Chinook salmon populations. Plans are underway to re-establish a spring-run Chinook salmon experimental population downstream of Friant Dam in the San Joaquin River, as part of the San Joaquin River Settlement Agreement. This would be done with Feather River Hatchery stock. Interim flows for this began in 2009.. Its long-term contribution to the CV spring-run Chinook salmon ESU is uncertain. It is clear that further efforts would need to involve more than restoration of currently accessible watersheds to make the ESU viable. The draft CV Recovery Plan calls for reestablishing populations into historical habitats currently blocked by large dams, such as a population upstream of Shasta

Dam. It also calls to facilitate passage of fish upstream and downstream of Englebright Dam on the Yuba River (NMFS 2009b).

3. Diversity

The CV spring-run Chinook salmon ESU is comprised of two genetic complexes. Analysis of natural and hatchery spring-run Chinook salmon stocks in the CV indicates that the northern Sierra Nevada diversity group spring-run Chinook salmon populations in Mill, Deer, and Butte creeks retains genetic integrity as opposed to the genetic integrity of the Feather River population, which has been somewhat compromised. The Feather River spring-run Chinook salmon have introgressed with the fall-run Chinook salmon, and it appears that the Yuba River population may have been impacted by FRFH fish straying into the Yuba River. Additionally, the diversity of the spring-run Chinook salmon ESU has been further reduced with the loss of the majority, if not all, of the San Joaquin River basin spring-run Chinook salmon populations. Efforts underway, like the San Joaquin Restoration Project, are needed to improve the diversity of the CV spring-run Chinook salmon ESU.

Summary of CV Spring-run Chinook salmon DPS Viability

Lindley et al. (2007) indicated that the spring-run Chinook salmon populations in the CV had a low risk of extinction in Butte and Deer creeks, according to their population viability analysis (PVA) model and other population viability criteria (i.e., population size, population decline, catastrophic events, and hatchery influence, which correlate with VSP parameters abundance, productivity, spatial structure, and diversity). The Mill Creek population of spring-run Chinook salmon was at moderate extinction risk according to the PVA model, but appeared to satisfy the other viability criteria for low-risk status. However, the CV spring-run Chinook salmon population failed to meet the "representation and redundancy rule" since there are only demonstrably viable populations in one diversity group (northern Sierra Nevada) out of the three diversity groups that historically contained them. Over the long term, these remaining populations are considered to be vulnerable to catastrophic events, such as volcanic eruptions from Mount Lassen or large forest fires due to the close proximity of their headwaters to each other. Drought is also considered to pose a significant threat to the viability of the spring-run Chinook salmon populations in these three watersheds due to their close proximity to each other. One large event could eliminate all three populations.

In the 2011 California CV status review for spring-run Chinook salmon, NMFS identified the status of CV spring-run Chinook salmon ESU as having probably deteriorated since the 2005 status review and Lindley et al.'s (2007) assessment, with two of the three extant independent populations (Deer and Mill creeks) of spring-run Chinook salmon slipping from low or moderate extinction risk to high extinction risk. Since the abundance of some populations is improving, though this is based on only two years (2012 and 2013), the extinction risk of Sacramento tributary populations generally has improved from high to moderate.

Critical Habitat and Primary Constituent Elements for CV Spring-Run Chinook Salmon

Critical habitat was designated for CV spring-run Chinook salmon on September 2, 2005, (70 FR 52488). Critical habitat for CV spring-run Chinook salmon includes stream reaches of the Feather, Yuba and American rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the Sacramento River, as well as portions of the northern Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of one to two years on the annual flood series) (Bain and Stevenson 1999; 70 FR 52488). Critical habitat for CV spring-run Chinook salmon is defined as specific areas that contain the primary constituent elements (PCEs) essential to the conservation of the species. Following are the inland habitat types used as PCEs for CV spring-run Chinook salmon.

1. Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most spawning habitat in the CV for Chinook salmon is located in areas directly downstream of dams containing suitable environmental conditions for spawning and incubation. Spawning habitat for CV spring-run Chinook salmon occurs on the mainstem Sacramento River between RBDD and Keswick Dam and in tributaries such as Mill, Deer, and Butte creeks; as well as the Feather and Yuba rivers, Big Chico, Battle, Antelope, and Clear creeks. However, little spawning activity has been recorded in recent years on the Sacramento River mainstem for spring-run Chinook salmon. Even in degraded reaches, spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of listed salmonids.

2. Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile salmonid development; and natural cover such as shade, submerged and overhanging large woody material, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system (*e.g.*, the lower Cosumnes River, Sacramento River reaches with setback levees [*i.e.*, primarily located upstream of the City of Colusa]) and flood bypasses (*i.e.*, Yolo and Sutter bypasses). However, the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system typically have low habitat complexity, low abundance of food organisms, and offer little protection from piscivorous fish and birds. Freshwater rearing habitat also has a high intrinsic conservation value even if the current conditions are significantly degraded from their natural state. Juvenile life stages of salmonids are dependent on the function of this habitat for successful survival and recruitment.

3. Freshwater Migration Corridors

Ideal freshwater migration corridors are free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. They contain natural cover such as riparian canopy structure, submerged and overhanging large woody objects, aquatic vegetation, large rocks, and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Migratory corridors are downstream of the spawning areas and include the lower mainstems of the Sacramento and San Joaquin rivers and the Delta. These corridors allow the upstream passage of adults, and the downstream emigration of juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For adults, upstream passage through the Delta and much of the Sacramento River is not a problem, yet a number of challenges exist on many tributary streams. For juveniles, unscreened or inadequately screened water diversions throughout their migration corridors and a scarcity of complex in-river cover have degraded this PCE. However, since the primary migration corridors are used by numerous populations, and are essential for connecting early rearing habitat with the ocean, even the degraded reaches are considered to have a high intrinsic conservation value to the species.

4. Estuarine Areas

Estuarine areas free of migratory obstructions with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water are included as a PCE. Natural cover such as submerged and overhanging large woody material, aquatic vegetation, and side channels, are suitable for juvenile and adult foraging.

The remaining estuarine habitat for these species is severely degraded by altered hydrologic regimes, poor water quality, reductions in habitat complexity, and competition for food and space with exotic species. Regardless of the condition, the remaining estuarine areas are of high conservation value because they provide factors which function to provide predator avoidance, as rearing habitat and as an area of transition to the ocean environment.

2.2.3 California Central Valley steelhead

CCV steelhead were listed as threatened on March 19, 1998, (63 FR 13347). Following a new status review (Good *et al.* 2005) and after application of the agency's hatchery listing policy, the NMFS reaffirmed its status as threatened and also listed several hatchery stocks as part of the DPS in 2006 (71 FR 834). In June 2004, after a complete status review of 27 west coast salmonid ESUs, the NMFS proposed that CCV steelhead remain listed as threatened (69 FR 33102). On January 5, 2006, NMFS reaffirmed the threatened status of the CCV steelhead and applied the DPS policy to the listed steelhead ESUs because the resident and anadromous life forms of *O.*

mykiss remain "markedly separated" as a consequence of physical, ecological and behavioral factors, and therefore warranted delineation as a separate DPS (71 FR 834). On August 15, 2011, the NMFS completed another 5-year status review of CCV steelhead and recommended that the CCV steelhead DPS remain classified as a threatened species (NMFS 2011a).

Critical habitat was designated for CCV steelhead on September 2, 2005, (70 FR 52488). Critical habitat includes the stream channels to the ordinary high water line within designated stream reaches such as those of the American, Feather, and Yuba rivers, and Deer, Mill, Battle, Antelope, and Clear creeks in the Sacramento River basin; the Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced rivers in the San Joaquin River basin; and the Sacramento and San Joaquin rivers and Delta. Currently the CCV steelhead DPS and its designated critical habitat extends up the San Joaquin River upstream to the confluence with the Merced River.

Life History

1. Migratory Forms Present in CV

Steelhead in the CV historically consisted of both summer-run and winter-run migratory forms, based on their state of sexual maturity at the time of river entry and the duration of their time in freshwater before spawning. Between 1944 and 1947, annual counts of summer-run steelhead passing through the Old Folsom Dam fish ladder during May, June, and July ranged from 400 to 1,246 fish (Gerstung 1971). After 1950, when the fish ladder at Old Folsom Dam was destroyed by flood flows, summer-run steelhead were no longer able to access their historic spawning areas, and either perished in the warm water downstream of Old Folsom Dam or hybridized with winter-run steelhead. Only winter-run (ocean maturing) steelhead currently are found in California CV rivers and streams (Moyle 2002; McEwan and Jackson 1996). Summer-run steelhead have been extirpated due to a lack of access to suitable holding and staging habitat, such as coldwater pools in the headwaters of CV streams, presently located upstream of impassible dams (Lindley *et al.* 2006).

2. <u>Age Structure</u>

Juvenile steelhead (parr) rear in freshwater for one to three years before outmigrating to the ocean as smolts (Moyle 2002). The time that parr spend in freshwater is related to their growth rate, with larger, faster-growing members of a cohort smolting at an earlier age (Peven *et al.* 1994; Seelbach 1993). Hallock *et al.* (1961) aged 100 adult steelhead caught in the Sacramento River upstream of the Feather River confluence in 1954, and found that 70 had smolted at age-2, 29 at age-1, and one at age-3. Seventeen of the adults were repeat spawners, with three fish on their third spawning migration, and one on its fifth. Age at first maturity varies among populations. In the CV, most steelhead return to their natal streams as adults at a total age of two to four years (Hallock 1961, McEwan and Jackson 1996).

3. <u>Egg to Parr Stages</u>

Steelhead eggs hatch in three to four weeks at 10°C to 15°C (Moyle 2002). The length of time it takes for eggs to hatch depends mostly on water temperature. After hatching, alevins remain in the gravel for an additional two to five weeks while absorbing their yolk sacs, and emerge in spring or early summer (Barnhart 1986). Fry emerge from the gravel usually about four to six weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can speed or retard this time (Shapovalov and Taft 1954). Upon emergence, fry inhale air at the stream surface to fill their air bladders, absorb the remains of their yolks in the course of a few days, and start to feed actively, often in schools (Barnhart 1986; NMFS 1996).

The newly emerged juveniles move to shallow, protected areas associated within the stream margin (McEwan and Jackson 1996). As steelhead parr increase in size and their swimming abilities improve, they increasingly exhibit a preference for higher velocity and deeper mid-channel areas (Hartman 1965; Everest and Chapman 1972; Fontaine 1988).

4. Preferred Juvenile Habitat

Productive juvenile rearing habitat is characterized by complexity, primarily in the form of cover, which can be deep pools, woody debris, aquatic vegetation, or bolders. Cover is an important habitat component for juvenile steelhead both as velocity refugia and as a means of avoiding predation (Meehan and Bjornn 1991). Optimal water temperatures for growth range from 15°C to 20°C (McCullough *et al.* 2001, Spina 2006).

5. Smolt Migration

Juvenile steelhead will often migrate downstream as parr in the summer or fall of their first year of life (USFWS 2002), but this is not a true smolt migration (Loch *et al.* 1988). Smolt migrations occur in the late winter through spring, when juveniles have undergone a physiological transformation to survive in the ocean, and become slender in shape, bright silvery in coloration, with no visible parr marks. Emigrating steelhead smolts use the lower reaches of the Sacramento River and the Delta primarily as a migration corridor to the ocean. There is little evidence that they rear in the Delta or on floodplains, though there are few behavioral studies of this life-stage in the CV.

6. Ocean Behavior

Unlike Pacific salmon, steelhead do not appear to form schools in the ocean (Behnke 1992). Steelhead in the southern part of their range appear to migrate close to the continental shelf, while more northern populations may migrate throughout the northern Pacific Ocean (Barnhart 1986).

7. Adult Run-Timing and Spawning Habitat

CCV steelhead generally leave the ocean from August through April (Busby *et al.* 1996), enter freshwater from August to November with a peak in September (Hallock 1961), and spawn from December to April, with a peak in January through March, in rivers and streams where cold, well oxygenated water is available (Table 8; Williams 2006; Hallock *et al.* 1961; McEwan and Jackson 1996). Timing of upstream migration is correlated with higher flow events, such as freshets, and the associated change in water temperatures (Workman *et al.* 2002). Adults typically spend a few months in freshwater before spawning (Williams 2006). Female steelhead construct redds in suitable gravel and cobble substrate, primarily in pool tailouts and heads of riffles.

8. Fecundity

The number of eggs laid per female is highly correlated with adult size, though the strain of the fish can also play a role. Adult steelhead size depends on the duration of and growth rate during their ocean residency (Meehan and Bjornn 1991). CCV steelhead generally return to freshwater after one to two years at sea (Hallock *et al.* 1961), and adults typically range in size from two to twelve pounds (Reynolds *et al.* 1993). Steelhead about 55 cm long may have fewer than 2,000 eggs, whereas steelhead 85 cm long can have 5,000 to 10,000 eggs, depending on the stock (Meehan and Bjornn 1991). The average for Coleman National Fish Hatchery (CNFH) since 1999 is about 3,900 eggs per female (USFWS 2011).

9. Iteroparity

Unlike Pacific salmon, steelhead are iteroparous, meaning they are capable of spawning multiple times before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; and repeat spawners tend to be biased towards females (Busby *et al.* 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapovalov and Taft (1954) reported that repeat spawners were relatively numerous (17.2 percent) in Waddell Creek. Null *et al.* (2013) found between 36 percent and 48 percent of kelts released from CNFH in 2005 and 2006 survived to spawn the following spring, which is in sharp contrast to what Hallock (1989) reported for CNFH in the 1971 season, where only 1.1 percent of adults were fish that had been tagged the previous year. Most populations have never been studied to determine the percentage of repeat spawners. Hatchery steelhead are typically less likely than wild fish to survive to spawn a second time (Leider *et al.* 1986).

10. Kelts

Post-spawning steelhead (kelts) may migrate downstream to the ocean immediately after spawning, or they may spend several weeks holding in pools before outmigrating (Shapovalov and Taft 1954). Recent studies have shown that kelts may remain in freshwater for an entire year after spawning (Teo *et al.* 2011), but that most return to the ocean (Null *et al.* 2013).

11. Population Dynamics

Historic CCV steelhead run sizes are difficult to estimate given the paucity of data, but may have approached one to two million adults annually (McEwan 2001). By the early 1960s the steelhead run size had declined to about 40,000 adults (McEwan 2001). Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River upstream of the Feather River. Steelhead counts at the RBDD declined from an average of 11,187 for the period from 1967 to 1977, to an average of approximately 2,000 through the early 1990's, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations.

About 80 percent of the historical spawning and rearing habitat once used by anadromous *O. mykiss* in the CV is now upstream of impassable dams (Lindley *et al.* 2006). The extent of habitat loss for steelhead most likely was much higher than that for salmon because steelhead were undoubtedly more extensively distributed. Due to their superior jumping ability, the timing of their upstream migration which coincided with the winter rainy season, and their less restrictive preferences for spawning gravels, steelhead could have utilized at least hundreds of miles of smaller tributaries not accessible to the earlier-spawning salmon (Yoshiyama *et al.* 1996). Steelhead were found as far south as the Kings River (and possibly Kern river systems in wet years) (McEwan 2001). Native American groups such as the Chunut people have had accounts of steelhead in the Tulare Basin (Latta 1977).

Nobriga and Cadrett (2003) compared CWT and untagged (wild) steelhead smolt catch ratios at Chipps Island trawl from 1998 through 2001 to estimate that about 100,000 to 300,000 steelhead smolts are produced naturally each year in the CV. Good *et al.* (2005) made the following conclusion based on the Chipps Island data:

> *"If we make the fairly generous assumptions (in the sense of generating large estimates of spawners) that average fecundity is 5,000 eggs per female, 1 percent of eggs survive to reach Chipps Island, and 181,000 smolts are produced (the 1998-2000 average), about 3,628 female steelhead spawn naturally in the entire CV. This can be compared with McEwan's (2001) estimate of 1 million to 2 million spawners before 1850, and 40,000 spawners in the 1960s."*

Existing naturally produced steelhead stocks in the CV are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill creeks and the Yuba River. Populations may exist in Big Chico and Butte creeks and a few wild steelhead are produced in the American and Feather rivers (McEwan and Jackson 1996). Clear Creek steelhead spawner abundance has not been estimated.

Until recently, CCV steelhead were thought to be extirpated from the San Joaquin River system. Monitoring has detected small numbers of steelhead in the Stanislaus, Mokelumne, and Calaveras rivers, and other streams previously thought to be devoid of steelhead (McEwan 2001). On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995. A counting weir has been in place in the Stanislaus River since 2002 and in the Tuolumne River since 2009 to detect adult salmon, and have also detected *O. mykiss* passage. In 2012, 15 adult *O. mykiss* were detected passing the Tuolumne River weir and 82 adult *O. mykiss* were detected at the Stanislaus River weir (FishBio 2012a,b). In addition, rotary screw trap sampling has occurred since 1995 in the Tuolumne River, but only one juvenile *O. mykiss* was caught during the 2012 season (FishBio 2012b). Rotary screw traps are well known to be very inefficient at catching steelhead smolts, so the actual numbers of smolts could be much higher. Rotary screw trapping on the Merced River has occurred since 1999. A fish counting weir was installed on this river in 2012. Since installation, one adult *O. mykiss* has been reported passing the weir. Juvenile *O. mykiss* were not reported captured in the rotary screw traps on the Merced River until 2012, when a total of 381 were caught (FishBio 2013). The unusually high number of *O. mykiss* captured may be attributed to a flashy storm event that rapidly increased flows over a 24 hour period. Zimmerman *et al.* (2009) has documented CCV steelhead in the Stanislaus, Tuolumne, and Merced rivers based on otolith microchemistry.

CDFW conducts annual Kodiak trawl sampling on the San Joaquin River near Mossdale. Based on these catches, as well as rotary screw trap efforts in all three tributaries, Marston (2004) stated that it is "clear from this data that *O. mykiss* do occur in all the tributaries as migrants and that the vast majority of them occur on the Stanislaus River." Mossdale Kodiak trawl catches continue to occur and are still being conducted by CDFW. The low adult returns to these tributaries and the low numbers of juvenile emigrants captured suggest that existing populations of CCV steelhead on the Tuolumne, Merced, and lower San Joaquin rivers are severely depressed. The loss of these populations would severely impact CCV steelhead spatial structure and further challenge the viability of the CCV steelhead DPS.

In the Mokelumne River, East Bay Municipal Utilities District has included steelhead in their redd surveys on the Lower Mokelumne River since the 1999-2000 spawning season (NMFS 2011a). Based on data from these surveys, the overall trend suggests that redd numbers have slightly increased over the years (2000-2010). However, according to Satterthwaite *et al.* (2010), it is likely that most of the *O. mykiss* spawning in the Mokelumne River are non-anadromous (or resident) fish rather than steelhead. The Mokelumne River steelhead population is supplemented by Mokelumne River Hatchery production. In the past, this hatchery received fish imported from the Feather River and Nimbus hatcheries (Merz 2002). However, this practice was discontinued 11 years ago for Nimbus stock, and 3 years ago for Feather River stock. Recent results show that the Mokelumne River Hatchery steelhead are closely related to Feather River fish, suggesting that there has been little carry-over of genes from the Nimbus stock.

Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin Basin continue to show a decline, an overall low abundance, and fluctuating return rates. Lindley *et al.* (2007) developed viability criteria for CV salmonids. Using data through 2005, Lindley *et al.* (2007) found that data were insufficient to determine the status of any of the naturally-spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, which were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas.

The most recent status review of the CCV steelhead DPS (NMFS 2011a) found that the status of the population appears to have worsened since the 2005 status review (Good *et al.* 2005), when it was considered to be in danger of extinction. Analysis of data from the Chipps Island monitoring program indicates that natural steelhead production has continued to decline and that hatchery origin fish represent an increasing fraction of the juvenile production in the CV. Since 1998, all hatchery produced steelhead in the CV have been adipose fin clipped (ad-clipped). Since that time, the trawl data indicates that the proportion of ad-clip steelhead juveniles captured in the Chipps Island monitoring trawls has increased relative to wild juveniles, indicating a decline in natural production of juvenile steelhead. In recent years, the proportion of hatchery produced juvenile steelhead in the catch has exceeded 90 percent and in 2010 was 95 percent of the catch.

Because hatchery releases have been fairly consistent through the years, this data suggests that the natural production of steelhead has been declining in the CV.

Salvage of juvenile steelhead at the CVP and SWP fish collection facilities has also shown a shift towards reduced natural production. In the past decade, there has been a decline in the percentage of salvaged juvenile steelhead that are naturally produced from 55 percent in 1998 down to 22 percent in 2010 (NMFS 2011a).

In contrast to the data from Chipps Island and the CVP and SWP fish collection facilities, some populations of wild CCV steelhead appear to be improving (Clear Creek) while others (Battle Creek) appear to be better able to tolerate the recent poor ocean conditions and dry hydrology in the CV compared to hatchery produced fish (NMFS 2011a). Since 2003, fish returning to the CNFH have been identified as wild (adipose fin intact) or hatchery produced (Ad-clipped). Returns of wild fish to the hatchery have remained fairly steady at 200-300 fish per year, but represent a small fraction of the overall hatchery returns. Numbers of hatchery origin fish returning to the hatchery have fluctuated much more widely; ranging from 624 to 2,968 fish per year. The returns of wild fish remained steady, even during the recent poor ocean conditions and the 3-year drought in the CV, while hatchery produced fish showed a decline in the numbers returning to the hatchery (NMFS 2011a). Furthermore, the continuing widespread distribution of wild steelhead in the CV provides the spatial distribution necessary for the DPS to survive and avoid localized catastrophes. However, these populations are frequently very small, and lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change (NMFS 2011a).

Table 8. The temporal occurrence of (a) adult and (b) juvenile CCV steelhead at locations in the CV. Darker shades indicate months of greatest relative abundance.

(a) Adult migration and holding

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[1,3]Sac. River												
[2,3]Sac R at Red Bluff												
[4]Mill, Deer Creeks												
[6]Sac R. at Fremont Weir												
[6]Sac R. at Fremont Weir												
[7]San Joaquin River												

(b) Juvenile migration

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[1,2]Sacramento River												
[2,8]Sac. R at KL												
[9]Sac. River @ KL												
[10]Chipps Island (wild)												
[8]Mossdale												
[11]Woodbridge Dam												
[12]Stan R. at Caswell												
[13]Sac R. at Hood												

Relative Abundance: = High = Medium = Low

Sources: [1]Hallock 1961; [2]McEwan 2001;[3]USFWS unpublished data; [4]CDFG 1995; [5]Hallock *et al.* 1957; [6]Bailey 1954; [7]CDFG Steelhead Report Card Data 2007;[8]CDFG unpublished data; [9]Snider and Titus 2000; [10]Nobriga and Cadrett 2003; [11]Jones and Stokes Associates, Inc., 2002; [12]S.P. Cramer and Associates Inc. 2000 and 2001; [13]Schaffter 1980, 1997.

Description of VSP Parameters

1. Abundance

All indications are that natural CCV steelhead have continued to decrease in abundance and in the proportion of natural fish over the past 25 years (Good *et al.* 2005; NMFS 2011a); the long-term trend remains negative. Comprehensive steelhead population monitoring has not taken place in the CV, despite 100 percent marking of hatchery steelhead since 1998. Efforts are underway to improve this deficiency, and a long term adult escapement monitoring plan is being considered (Eilers *et al.* 2010). Hatchery production and returns are dominant over natural fish and include significant numbers of non-DPS-origin Eel/Mad River steelhead stock. Continued decline in the ratio between naturally produced juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts indicates that the wild population abundance is declining. Hatchery releases (100 percent adipose fin clipped fish since 1998) have remained relatively constant over the past decade, yet the proportion of adipose fin-clipped hatchery smolts to unclipped naturally produced smolts has steadily increased over the past several years.

2. Productivity

An estimated 100,000 to 300,000 naturally produced juvenile steelhead are estimated to leave the CV annually, based on rough calculations from sporadic catches in trawl gear (Good *et al.* 2005). The Mossdale trawls on the San Joaquin River conducted annually by CDFW and USFWS capture steelhead smolts, although usually in very small numbers. These steelhead recoveries which represent migrants from the Stanislaus, Tuolumne, and Merced rivers suggest that existing populations of CCV steelhead on these tributaries are severely depressed. In addition, the Chipps Island midwater trawl dataset from the USFWS provides information on the trend (Williams *et al.* 2011).

3. Spatial Structure

Steelhead appear to be well-distributed throughout the CV (Good *et al.* 2005; NMFS 2011a). In the San Joaquin River Basin, steelhead have been confirmed in all of the tributaries: Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced rivers. Zimmerman *et al.* (2009) used otolith microchemistry to show that *O. mykiss* of anadromous parentage occur in all three major San Joaquin River tributaries, but at low levels, and that these tributaries have a higher percentage of resident *O. mykiss* compared to the Sacramento River and its tributaries. The efforts to provide passage of salmonids over impassable dams may increase the spatial diversity of CCV steelhead populations if the passage programs are implemented for steelhead. In addition, the San Joaquin River Restoration Program (SJRRP) calls for a combination of channel and structural modifications along the San Joaquin River downstream of Friant Dam, releases of water from Friant Dam to the confluence of the Merced River, and the reintroduction of spring-run and fall-run Chinook salmon. If the SJRRP is successful, habitat improved for spring-run Chinook salmon could also benefit CCV steelhead (NMFS 2011a).

4. Diversity

CCV steelhead abundance and growth rate continue to decline, largely the result of a significant reduction in the diversity of habitats available to CCV steelhead (Lindley *et al.* 2006). Recent reductions in population size are also supported by genetic analysis (Nielsen *et al.* 2003). Garza and Pearse (2008) analyzed the genetic relationships among CCV steelhead populations and found that unlike the situation in coastal California watersheds, fish downstream of barriers in the CV were more closely related to downstream of barrier fish from other watersheds than to *O. mykiss* upstream of barriers in the same watershed. This pattern suggests the ancestral genetic structure is still relatively intact upstream of barriers, but may have been altered below barriers by stock transfers. The genetic diversity of CCV steelhead is also compromised by hatchery origin fish, which likely comprise the majority of the spawning run, placing the natural population at a high risk of extinction (Lindley *et al.* 2007). There are four hatcheries (CNFH, FRFH, Nimbus Fish Hatchery, and Mokelumne River Fish Hatchery) in the CV which combined release approximately 600,000 yearling steelhead smolts each year. These programs are intended to compensate for the loss of steelhead habitat caused by dam construction, but hatchery origin fish now appear to constitute a major proportion of the total abundance in the DPS. Two of these hatchery stocks (Nimbus and Mokelumne River hatcheries) originated from outside the DPS (from the Eel and Mad rivers) and are not presently considered part of the DPS.

Summary of CCV Steelhead DPS Viability

All indications are that natural CCV steelhead have continued to decrease in abundance over the past 25 years (Good et al. 2005; NMFS 2011a). The long-term trend remains negative. Hatchery production and returns are dominant over natural fish. Continued decline in the ratio between naturally produced juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts indicates that the wild population abundance is declining. Hatchery releases (100 percent adipose fin clipped fish since 1998) have remained relatively constant over the past decade, yet the proportion of adipose fin-clipped hatchery smolts to unclipped naturally produced smolts has steadily increased over the past several years.

Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin Basin continue to show a decline, an overall low abundance, and fluctuating return rates. Lindley et al. (2007) developed viability criteria for CV salmonids. Using data through 2005, Lindley et al. (2007) found that data were insufficient to determine the status of any of the naturally-spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, which were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas.

The widespread distribution of wild steelhead in the CV provides the spatial distribution necessary for the DPS to survive and avoid localized catastrophes. However, these populations are frequently very small, and lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change (NMFS 2011a). The most recent status review of the CCV steelhead DPS (NMFS 2011a) found that the status of the population appears to have worsened since the 2005 status review (Good et al. 2005), when it was considered to be in danger of extinction.

Critical Habitat and Primary Constituent Elements for CCV Steelhead

Critical habitat was designated for CCV steelhead on September 2, 2005 (70 FR 52488). Critical habitat for CCV steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope creeks in the Sacramento River basin; the San Joaquin River, including its tributaries, and the waterways of the Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series) (Bain and Stevenson 1999; 70 FR 52488). Critical habitat for CCV steelhead is defined as specific areas that contain the PCE and physical habitat elements essential to the conservation of the species. Following are the inland habitat types used as PCEs for CCV steelhead. PCEs for CCV steelhead include:

1. Freshwater Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most of the available spawning habitat for steelhead in the CV is located in areas directly downstream of dams due to inaccessibility to historical spawning areas upstream and the fact that dams are typically built at high gradient locations. These reaches are often impacted by the upstream impoundments, particularly over the summer months, when high temperatures can have adverse effects upon salmonids spawning and rearing downstream of the dams. Even in degraded reaches, spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of listed salmonids.

2. Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and survival; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging LWM, log jams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system (*e.g.*, the lower Cosumnes River, Sacramento River reaches with setback levees [*i.e.*, primarily located upstream of the City of Colusa]) and flood bypasses (*i.e.*, Yolo and Sutter bypasses). However, the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Freshwater rearing habitat also has a high conservation value even if the current conditions are significantly degraded from their natural state. Juvenile life stages of salmonids are dependent on the function of this habitat for successful survival and recruitment.

3. Freshwater Migration Corridors

Ideal freshwater migration corridors are free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. They contain natural cover such as riparian canopy structure, submerged and overhanging large woody objects, aquatic vegetation, large rocks, and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Migratory corridors are downstream of the spawning areas and include the lower mainstems of the Sacramento and San Joaquin rivers and the Delta. These corridors allow the upstream and downstream passage of adults, and the emigration of smolts.

Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For this reason, freshwater migration corridors are considered to have a high conservation value even if the migration corridors are significantly degraded compared to their natural state.

4. Estuarine Areas

Estuarine areas free of migratory obstructions with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water are included as a PCE. Natural cover such as submerged and overhanging LWM, aquatic vegetation, and side channels, are suitable for juvenile and adult foraging. Estuarine areas are considered to have a high conservation value as they provide factors which function to provide predator avoidance and as a transitional zone to the ocean environment.

2.2.4 Southern DPS of North American Green Sturgeon

The following section entails the status of the species for the Southern distinct population segment of North American green sturgeon (sDPS green sturgeon). This section establishes the life history and viability for sDPS green sturgeon, and discusses their critical habitat. The critical habitat analysis is approached by examining the PCEs of that critical habitat, and this analysis considers separately freshwater and estuarine environments. Throughout this analysis of life history, viability, and critical habitat, the focus is upon the CV of California. Therefore, not all aspects of sDPS green sturgeon are presented; for example, the PCEs for the critical habitat in the marine environment are not included.

1. Listed as threatened on June 6, 2006 (71 FR 17757)
2. Critical habitat designated October 9, 2009 (74 FR 52300)

Life History

Our understanding of the biology of the sDPS of green sturgeon is evolving. In areas where information is lacking, inferences are sometimes made from what is known about the Northern distinct population segment (nDPS) green sturgeon and, to a lesser extent, from other sturgeon species, especially the sympatric white sturgeon (*Acipenser transmontanus*). Green sturgeon are long lived, iteroperous, anadromous fish. They may live up to 60-70 years; green sturgeon captured in Oregon have been age-estimated using a fin-spine analysis up to 52 years (Farr and Kern 2005). The green sturgeon sDPS includes those that spawn south of the Eel River. Until recently, it was believed that the green sturgeon sDPS was composed of a single spawning population on the Sacramento River. However, recent research conducted by DWR has revealed spawning activity in the Feather River (Seesholtz, A. M., M. J. Manuel, and J. P. Van Eenennaam). 2015. First documented spawning and associated habitat conditions for green sturgeon in the Feather River, California. Environmental Biology of Fishes 98:905-912.

Additionally, there is some evidence of spawning in the Yuba River downstream of Daguerre Point Dam (Cramer Fish Sciences 2013).

Laboratory studies have provided some important information about about larval sturgeon diet and habitat use. Green sturgeon larvae hatch from fertilized eggs after approximately 169 hours at a water temperature of 15° C (59° F) (Van Eenennaam *et al.* 2001, Deng *et al.* 2002). Studies conducted at the University of California, Davis by Van Eenennaam *et al.* (2005) using nDPS juveniles indicated that an optimum range of water temperature for egg development ranged between 14° C (57.2°F) and 17° C (62.6°F). Temperatures over 23 °C (73.4°F) resulted in 100 percent mortality of fertilized eggs before hatching. Eggs incubated at water temperatures between 17.5° C (63.5°F) and 22° C (71.6°F) resulted in elevated mortalities and an increased occurrence of morphological abnormalities in those eggs that did hatch. At incubation temperatures below 14° C (57.2°F), hatching mortality also increased significantly, and morphological abnormalities increased slightly, but not statistically so (Van Eenennaam *et al.* 2005).

Young green sturgeon appear to rear for the first one to two months in the Sacramento River between Keswick Dam and Hamilton City (CDFG 2002). Juvenile green sturgeon first appear in USFWS sampling efforts at RBDD in June and July at lengths ranging from 24 to 31 mm fork length, indicating they are approximately two weeks old (CDFG 2002, USFWS 2002). Growth is rapid as juveniles reach up to 300 mm the first year and over 600 mm in the first 2 to 3 years (Nakamoto *et al.* 1995). Juvenile green sturgeon have been salvaged at the Federal and State pumping facilities (which are located in the southern region of the Delta), and sampled in trawling studies by the CDFW during all months of the year (CDFG 2002). The majority of these fish that were captured in the Delta were between 200 and 500 mm indicating they were from 2 to 3 years of age, based on Klamath River age distribution work by Nakamoto *et al.* (1995). The lack of a significant proportion of juveniles smaller than approximately 200 mm in Delta captures indicates juvenile sDPS green sturgeon likely hold in the mainstem Sacramento River for up to 10 months, as suggested by Kynard *et al.* (2005). Both nDPS and sDPS green sturgeon juveniles tested under laboratory conditions, with either full or reduced rations, had optimal bioenergetic performance (*i.e.,* growth, food conversion, swimming ability) between 15°C (59° F) and 19° C (66.2° F), thus providing a temperature related habitat target for conservation of this rare species (Mayfield and Cech 2004). This temperature range overlaps the egg incubation temperature range for peak hatching success previously discussed.

Green sturgeon are opportunistic feeders that consume a variety of prey items. The diet of larval green sturgeon is unknown, but may be similar to that of larval white sturgeon which includes macrobenthic invertebrates, including various insect larvae, oligochaetes, and decapods (NMFS 2009). In the San Francisco Bay Delta Estuary, juvenile green sturgeon feed on shrimp, amphipods, isopods, clams, annelid worms, and an assortment of crabs and fish (Ganssle 1966; Radtke 1966). Post-spawn adult green sturgeon in freshwater most likely feed on benthic prey species (*e.g*., lamprey ammocoetes, crayfish). In coastal bays and estuaries, adult and subadult green sturgeon feed on shrimp, clams, and benthic fish (Moyle *et al*. 1995; Moser and Lindley 2007; Dumbauld *et al*. 2008). In the nearshore marine environment, prey resources likely include species similar to those of coastal bays and estuaries.

There is a fair amount of variability (1.5 – 4 years) in the estimates of the time spent by juvenile green sturgeon in freshwater before making their first migration to sea. Nakamoto *et al.* (1995) found that nDPS green sturgeon on the Klamath River migrated to sea, on average by age three and no later than by age four. Moyle (2002) suggests juveniles migrate out to sea before the end of their second year, and perhaps as yearlings. Laboratory experiments indicate that both nDPS and sDPS green sturgeon juveniles may occupy fresh to brackish water at any age, but they are physiologically able to completely transition to saltwater at around 1.5 years in age (Allen and Cech 2007). In studying nDPS green sturgeon on the Klamath River, Allen *et al.* (2009) devised a technique to estimate the timing of transition from fresh water to brackish water to seawater by taking a bone sample from the leading edge of the pectoral fin and anlyzing the ratios of stontium and barium to calcium. The results of this study indicate that green sturgeon move from freshwater to brackish water (such as the estuary) at ages 0.5–1.5 years and then move into seawater at ages 2.5-3.5 years. Table 9 shows the migration timing of various life stages throughout the CV, Delta, San Francisco Bay, and into the Pacific Ocean.

In the summer months, multiple rivers and estuaries throughout the sDPS range are visited by dense aggregations of green sturgeon (Moser and Lindley 2007, Lindley *et al.* 2011). Capture of green sturgeon as well as tag detections in tagging studies have shown that green sturgeon are present in San Pablo Bay and San Francisco Bay at all months of the year (Kelly *et al.* 2007, Heublein *et al.* 2009, Lindley *et al.* 2011). An increasing amount of information is becoming available regarding green sturgeon habitat use in estuaries and coastal ocean, and why they aggregate episodically (Lindley *et al.* 2008, Lindley *et al.* 2011). Genetic studies on green sturgeon stocks indicate that almost all of the green sturgeon in the San Francisco Bay ecosystem belong to the sDPS (Israel and Klimley 2008).

Green sturgeon do not mature until they are at least 15–17 years of age (Beamesderfer *et al.* 2007). Therefore, it would not be expected that a green sturgeon returning to freshwater would be younger than this. However, once mature, green sturgeon appear to make spawning runs once every few years. Erickson and Hightower (2007) found that nDPS green sturgeon returned to the Rogue River 2–4 years after leaving; it is presumed that sDPS green sturgeon display similar behavior and return to the Sacramento River or Feather River system to spawn every 2–5 years. Adult sDPS green sturgeon begin their upstream spawning migrations into freshwater as early as late February with spawning occuring between March and July (CDFG 2002, Heublein 2006, Heublein *et al.* 2009, Vogel 2008). Peak spawning is believed to occur between April and June in deep, turbulent, mainstem channels over large cobble and rocky substrates featuring crevices and interstices (Van Eenennaam *et al.* 2001). Poytress *et al.* (2012) conducted spawning site and larval sampling in the upper Sacramento River from 2008–2012 and has identified a number of confirmed spawning locations (Figure 6). Green sturgeon fecundity is approximately 50,000 to 80,000 eggs per adult female (Van Eenennaam *et al.* 2001). They have the largest egg size of any sturgeon. The outside of the eggs are mildly adhesive, and are more dense than than those of white sturgeon (Kynard *et al.* 2005, Van Eenennaam *et al.* 2009).

Post spawning, green sturgeon may exhibit a variety of behaviors. Ultimately they will return to the ocean, but how long they take to do this and what they do along the way are open questions. Illustrating the spectrum of behavioral choices, Benson *et al.* (2007) conducted a study in which 49 nDPS green sturgeon were tagged with radio and/or sonic telemetry tags and tracked manually or with receiver arrays from 2002 to 2004. Tagged individuals exhibited four movement patterns: upstream spawning migration, spring outmigration to the ocean, or summer holding, and outmigration after summer holding.

Table 9. The temporal occurrence of (a) adult, (b) larval (c) juvenile and (d) subadult coastal migrant sDPS of green sturgeon. Locations emphasize the CV of California. Darker shades indicate months of greatest relative abundance.

(a) Adult-sexually mature (≥145 – 205 cm TL for females and ≥ 120 – 185 cm TL old for males)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Sac. River[a,b,c.i]												
SF Bay Estuary[d,h,i]												
(b) Larval and juvenile (≤10 months old)												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RBDD, Sac River[e]												
GCID, Sac River[e]												
(c) Older Juvenile (> 10 months old and ≤3 years old)												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
South Delta*[f]												
Sac-SJ Delta[f]												
Sac-SJ Delta[e]												
Suisun Bay[e]												
(d) Sub-Adult/non-sexually mature (approx. 75 cm to 145 cm for females and 75 to 120 cm for males)												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pacific Coast[c,g]												

Relative Abundance: = High = Medium = Low

* Fish Facility salvage operations

Sources: [a]USFWS (2002); [b]Moyle *et al.* (1992); [c]Adams *et al.* (2002) and NMFS (2005); [d]Kelly *et al.* (2007); [e]CDFG (2002); [f]IEP Relational Database, fall midwater trawl green sturgeon captures from 1969 to 2003; [g]Nakamoto *et al.* (1995); [h]Heublein (2006); [i]CDFG Draft Sturgeon Report Card (2007)

Threats and Stressors

Green sturgeon are long lived, and thus face environmental and anthropocentric stressors that may affect the probability that they reach reproductive maturity. Males are observed to reproduce as early as 14 years old, while females grow older prior to maturing as early as 16 years old (Van Eenennaam et al. 2005). Both males and females occupy all types of aquatic environments- freshwater, estuarine, and marine. Numerous environmental factors potentially limit green sturgeon survival during the earliest stages of their life cycle while in freshwater. This period is called the "critical age" in fishes due to its relevance in survival and recruitment of individuals into the adult population (Hardy and Litvak 2004). Recruitment failure of the earliest life history stages may be a significant bottleneck for other North American acipenserids such as Pallid sturgeon and the white sturgeon in Upper Columbia and Kootenai rivers, the populations of which have numerous reproductive adults, but few recently surviving wild juveniles (Duke et al. 1999, Hildebrand et al. 1999, Korman and Walters 2001) .

There are many potential limiting factors during this early life period. They are the following: 1) warm water temperatures, 2) insufficient flows, 3) decreased dissolved oxygen, 4) lack of rearing habitat, and 5) increased predation. Water is released from Shasta Dam to maintain daily temperatures below 18º C downstream to a temperature compliance point, which in 2007 was maintained at Jellys Ferry and Balls Ferry to facilitate the incubation of eggs of spawning winter-run Chinook. This maintenance of cool water temperatures benefits green sturgeon spawning upstream of Red Bluff Diversion Dam. Temperature records from acoustic telemetry receivers along the mainstem have not been analyzed, but may provide data for assessing whether temperatures are limiting survival of embryos, larvae or juveniles downstream of RBDD. Once larvae grow into juveniles, their survival may be limited by lack of habitat, insufficient food, and possibly contaminants. Juveniles are fairly tolerant of variable temperature and dissolved oxygen, and are likely mobile enough to select favorable habitats (see Ecology sections). It is possible that juveniles can also be entrained in water diversions for farmland irrigation, although their benthic behavior likely limits this impact, and this is not well understood.

The members of the older age classes principally face anthropocentric threats to their survival in estuarine and marine environments. Once within the estuary, juveniles might accumulate pollutants such as methyl-mercury and pyrethroids, whose uptake is enhanced by the benthic feeding orientation of green sturgeon. Pyrethroids also may limit the availability of prey for young green sturgeon due to their effect of very low dosages on zooplankton and bottom-dwelling organisms. The size of the populations of subadults and adults have been potentially limited by human fisheries and barriers to spawning areas which may prevent them from racing the most optimal spawning habitats. Harvest can cause abrupt declines in green sturgeon adult abundance. Even an amount as small as 10% additional mortality over the green sturgeon's life-span can reduce population abundance by 50% and adult abundance by 90% (Beamesderfer et al. 2007). An additional simulated increase in mortality of 20% over natural mortality resulted in no green sturgeon surviving to adulthood. These forms of mortality could include human and nonhuman sources of direct mortality, and are not well quantified for the Southern DPS. Of greater concern, might be even much smaller additional mortality rates' influence on green sturgeon's reproductive potential. Additional rates of only 2-3% annual mortality over green sturgeon's life cycle reduced egg production to levels making sturgeon stocks extremely susceptible to overfishing (Beamesderfer et al. 2007).

Modification of the riverscape has resulted in loss of spawning habitat, rearing habitat, and increased barriers to migration. Larvae, juveniles, and adults life history stages are all benthic in orientation and all require deep habitats for dispersal, holding, and spawning. Successful fertilization and survival of embryos seems to require spawning habitats reflecting specific water quality and quantity parameters, which have been negatively impacted by construction of dams and channelization of the river. Riparian habitats provide allochthonous contributions to the river food web that indirectly support juvenile prey items. It is possible that modifications in temperature regime controlled by the Shasta Dam temperature control device may benefit green sturgeon spawning above Red Bluff Diversion Dam, but more research is necessary to understand the impacts of temperature on the distribution and success of green sturgeon spawning.

Channelization of the estuary has likely negative impacted the amount of subtidal and intertidal habitat available for green sturgeon foraging. These habitats have been lost along San Pablo and Suisun bays, where subadult and adult green sturgeon are commonly found. These estuarine habitats are likely important for growth during the juvenile, coastal migrant, and adults life stages. Invasive plant species in the estuary have likely impacted the quantity of shallow habitat available to coastal migrant and adult green sturgeon, and alterations of the food web due to invasive species have also likely shifted green sturgeon estuarine diet.

Future Research

One conclusion of the NMFS BRT assessing the status of green sturgeon was that "it is essential that immediate efforts be undertaken to implement population monitoring for the DPS using methods that directly assess population status" (NMFS 2005). Although laboratory studies have yielded much information on the physiological needs of the species, field studies have yet to be completed applying this information to identifying adult spawning, larval survival, juvenile rearing, and juvenile smoltification. Information is necessary about the life history diversity, abundance, population growth rate, foraging behavior and temporal presence of Sacramento River green sturgeon.

Managers should develop research and monitoring to estimate the riverine larval and juvenile populations for a period of time reflecting the potential variation in physical and biological processes influencing recruitment. These results will give managers an idea for the effect of management on critical habitats, influence of adult demography on recruitment dynamics, and the actual production of green sturgeon in younger cohorts. Estimates derived from these types of studies may be a good indication for spawning and abundance, which are not negatively influenced by the impact of entrainment, operations, and harvest. If estimates of young riverine fish are known, then adaptive research evaluating the impacts of anthropocentric stressors on older life history stages will allow managers to assess the actual effects of these anthropocentric stressors. Currently, abundance derived from harvest or operational entrainment data does not allow managers to determine if these impacts are causing declines in abundance or just reflect the natural production of spawning adults.

The distribution of spawning adults as well as a characterization of their spawning habitat within the Sacramento River should be completed. This will provide insight into the density of spawning adults and influence spawning aggregation have to the juvenile population, the rates of egg and larval mortality, and the potential loss of this spawning habitat by flow and temperature modification in the system. In 2008, UCD, BOR, and FWS initiated tracking green sturgeon as they move within the upper mainstem and collected eggs at spawning sites. Additional funding is necessary to adequately monitor spawning movements and increased egg and larval collection sites along the Sacramento riverscape to evaluate green sturgeon habitat relationships.

Little is known about green sturgeon food selection and foraging behavior making the predictability of where preferred food is available low. As green sturgeon move into lower riverine reaches, the estuary and marine environments, food resources are not well understood (Israel and Klimley 2008). If native food sources have declined due to invasive species occupying their habitat or pollutants reducing available food, finding sufficient food may be problematic for juvenile green sturgeon. There is a need to investigate further the effects of selenium and other contaminants on green sturgeon and to find ways to reduce sources. Recent evidence indicates adult white sturgeon may be accumulating selenium in concentrations detrimental to reproduction, presumably by consuming the introduced overbite clam (Linville 2006).

Support should be provided for priority research guided by the Interagency Ecological Program Sturgeon Work Team. This conceptual model should indicate that much is already known about the basic biology of green sturgeon from laboratory studies and can serve as the basis for developing hypotheses for testing in field studies. The next research step should be to discern the importance of this biology on population viability within the watershed. A systematically applied research program attempting to study the critical periods and habitats of green sturgeon in riverine and estuarine environments will provide managers with information on the actual utilization, status, and abundance of different life history stages of green sturgeon in the Sacramento River. Once these field observations are completed, our larger and more comprehensive understanding for the basic ecology of the species will permit the development of a population viability model, which could prioritize the above-mentioned risks to the population and guide management decisions (Israel and Klimley 2008).

Description of Viability Parameters for sDPS Green Sturgeon

As an approach to determining the conservation status of salmonids, NMFS has developed a framework for identifying attributes of a VSP. The intent of this framework is to provide parties with the ability to assess the effects of management and conservation actions and ensure their actions promote the listed species' survival and recovery. This framework is known as the VSP concept (McElhany *et al.* 2000). The VSP concept measures population performance in term of four key parameters: abundance, population growth rate, spatial structure, and diversity. Although the VSP concept was developed for Pacific salmonids, the underlying parameters are general principles of conservation biology and can therefore be applied more broadly; here we adopt the VSP concept for sPDS green sturgeon.

1. <u>Abundance</u>

Abundance is one of the most basic principles of conservation biology, and from this measurement other parameters can be related. In applying the VSP concept, abundance is examined at the population level, and therefore population size is perhaps a more appropriate term. Population estimates of the green sturgeon sDPS are in development. A decrease in sDPS green sturgeon abundance has been inferred from the amount of take observed at the south Delta pumping facilities; the Skinner Delta Fish Protection Facility (SDFPF) and the Tracy Fish Collection Facility (TFCF) (Figure 7). There are, however, uncertainties with the data in figure 7. Adams et al. (2007) describe that while the numbers of green sturgeon still were higher in the pre 1986 period, it appears that the expansion procedure exaggerated that difference. These entrainment estimates suffer from problems of species identification (green sturgeon were not identified until 1981 at the federal facility), and the estimates are expanded catches from brief sampling periods.

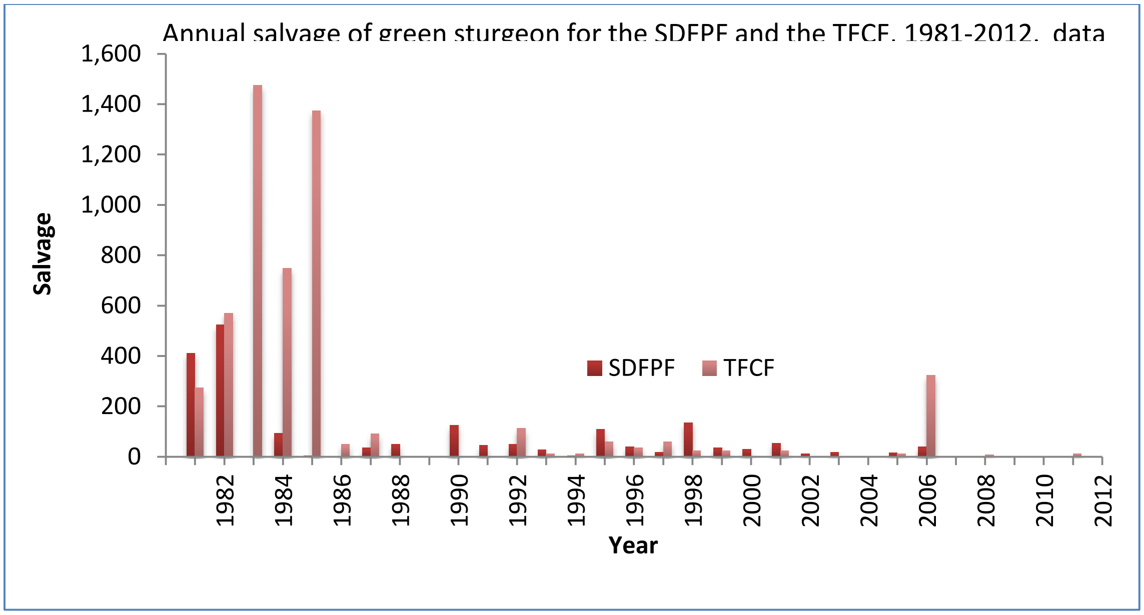

Figure 7. Annual salvage of green sturgeon for the SDFPF and the TFCF from 1981 to 2012. Data source: ftp://ftp.delta.dfg.ca.gov/salvage

Adult spawning population estimates in the upper Sacramento River (above RBDD*)*, using sibling based genetics, indicates 10-28 spawners contributed to juvenile production per year between 2002-2006 (Israel and May 2010). This is a minimum estimate of the effective adult spawning population because sampling was limited, may have preferentially selected for larvae spawning immediately above RBDD, and did not include animals spawning downstream of the RBDD. Fish monitoring efforts at RBDD and Glen Colusa Irrigation District (GCID) on the upper Sacramento River have captured anywhere between 0 and 2,068 juvenile green sturgeon per year, between 1986 and 2000 (Adams *et al.* 2002).

In determining the conservation status of sDPS green sturgeon, a few notes with regards to population size are crucial. Population(s) should be large enough to survive environmental variations, catastrophes, and anthropogenic perturbations. Also, the population(s) should be sufficiently large to maintain long term genetic diversity (McElhany *et al.* 2000). Our understanding of the status of sDPS green sturgeon towards these concerns is developing.

Because of their long life span, green sturgeon abundance is particularly sensitive to increased mortality. Even relatively small increases in annual mortality can substantially reduce adult abundance due to cumulative effects accruing over a number of years. Because of their delayed age of maturation, cumulative impacts may severely reduce the population's reproduction potential.

Beamesderfer *et al*. (2007) used the life table model to evaluate the sensitivity of the population to additional mortality rates when applied to different life stages. The analyses showed that low rates of additional mortality (2% to 5%), when applied across multiple life stages, can result in abrupt declines in green sturgeon population numbers and reproductive potential.

2. <u>Productivity</u>

For long-lived species such as sturgeon, abundance, age structure, and sex ratios are particularly powerful indicators of long-term productivity patterns. Viable sturgeon populations are characterized by a broad distribution of size classes and ages. In order for sDPS green sturgeon to rebound from being threatened to a viable status, its population growth rate will need to be positive until some equilibrium population size is reached, at which point the growth rate should stabilize.

Productivity and recruitment information for sDPS green sturgeon is an area that requires additional research; existing data is too limited to be presented as robust estimates. Incidental catches of larval green sturgeon in the mainstem Sacramento River and of juvenile green sturgeon at the south Delta pumping facilities suggest that green sturgeon are successful at spawning, but that annual year class strength may be highly variable (Beamesderfer *et al.* 2007, Lindley *et al.* 2007). In general, sturgeon year class strength appears to be episodic with overall abundance dependent upon a few successful spawning events (NMFS 2010). It is unclear if the population is able to consistently replace itself. This is significant because the VSP concept requires that a population meeting or exceeding the abundance criteria for viability should, on average, be able to replace itself (McElhany *et al*. 2000). More research is needed to establish green sturgeon sDPS productivity.

3. <u>Spatial Structure</u>

Green sturgeon, as a species, are known to range from Baja California to the Bering Sea along the North American continental shelf. During the late summer and early fall, subadults and nonspawning adult green sturgeon frequently can be found aggregating in estuaries along the Pacific coast (Emmett 1991, Moser and Lindley 2007). Based on genetic analyses and spawning site fidelity (Adams *et al.* 2002, Israel *et al.* 2004), green sturgeon are comprised of at least two DPSs.

1. A nDPS consisting of populations originating from coastal watersheds northward of and including the Eel River (*i.e.* Klamath, Rogue, and Umpqua rivers), and

2. A sDPS consisting of populations originating from coastal watersheds south of the Eel River.

Throughout much of their range, sDPS and nDPS green sturgeon are known to co-occur, especially in northern estuaries and over-wintering grounds. However, those green sturgeon that are found within the inland waters of the Central Valley, California are almost entirely sDPS green sturgeon (Israel and Klimley 2008).

Adams *et al.* (2007) summarizes information that suggests green sturgeon may have been distributed upstream of the locations of present-day dams on the Sacramento and Feather rivers. In the California CV, sDPS green sturgeon are known to range from the Delta to the Sacramento River up to Keswick Dam, the Feather River up to the fish barrier structure downstream of Oroville Dam, and the Yuba River up to Daguerre Point Dam. Additional habitat may have historically existed in the San Joaquin River basin. Anecdotal evidence from anglers suggest sDPS green sturgeon presence in the San Joaquin River. Since implementation of the Sturgeon Report Card in 2007, anglers have reported catching 177 white sturgeon and 7 green sturgeon on the San Joaquin River upstream from Stockton (Dubois, J., M. D. Harris, and J. Mauldin. 2014. 2013 Sturgeon Fishing Report Card: Preliminary Data Report. CDFW Bay Delta Region, Stockton, CA, May 8, 2014).

In applying the VSP concept to sDPS green sturgeon, it is important to look at the within-population spatial diversity. Ongoing research is being conducted to determine if the green sturgeon sDPS is composed of a single population, or perhaps several populations. It is known that sDPS green sturgeon spawn in the mainstem Sacramento River, the Feather River, and the Yuba River; but it is not yet known if these spawning areas represent individual populations, sub-populations, or if they are all part of one single population. However, it is encouraging to note that at least this level of spatial diversity exists; when sDPS green sturgeon were originally listed as threatened under the ESA, the only known spawning locations at the time were those on the mainstem Sacramento River.

4. <u>Diversity</u>

The VSP concept identifies a variety of traits that exhibit diversity within and among populations, and this variation has important effects on population viability (McElhany *et al.* 2000). For sDPS green sturgeon, such traits include, but are not limited to fecundity, age at maturity, physiology, and genetic characteristics. On a species-wide scale, studies have examined the genetic differentiation between sDPS and nDPS green sturgeon (Israel *et al.* 2004).

Although the population structure of sDPS green sturgeon is still being refined, it may be the case that only a single population exists. This may have the effect of providing for lower diversity than if two or more populations existed. Lindley *et al.* (2007), in discussing winter-run Chinook salmon, states that an ESU represented by a single population at moderate risk of extinction is at high risk of extinction over the long run. This concern applies to any DPS or ESU represented by a single population.

Summary of sDPS Green Sturgeon Viability

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate because, although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS 2010a). Viability is defined as an independent population having a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year timeframe (McElhany et al. 2000). The best available scientific information does not indicate that the extinction risk facing sDPS green sturgeon is negligible over a long term (~100 year) time horizon; therefore the sDPS is not believed to be viable. To support this statement, the population viability analysis (PVA) that was done for sDPS green sturgeon in relation to stranding events (Thomas et al. 2013) may provide some insight. While this PVA model made many assumptions that need to be verified as new information becomes available, it was alarming to note that over a 50-year time period the DPS declined under all scenarios where stranding events were recurrent over the lifespan of a green sturgeon.

Although the population structure of sDPS green sturgeon is still being refined, it is currently believed that only one population of sDPS green sturgeon exists. Lindley et al. (2007), in discussing winter-run Chinook salmon, states that an ESU represented by a single population at moderate risk of extinction is at high risk of extinction over the long run. This concern applies to any DPS or ESU represented by a single population, and if this were to be applied to sDPS green sturgeon directly, it could be said that sDPS green sturgeon face a high extinction risk. However, the position of NMFS, upon weighing all available information (and lack of information) has stated the extinction risk to be moderate (NMFS 2010a).

There is a strong need for additional information about sDPS green sturgeon, especially with regards to a robust abundance estimate, a greater understanding of their biology, and further information about their habitat needs.

Southern DPS of North American Green Sturgeon Critical Habitat

Critical habitat was designated for the sDPS green sturgeon on October 9, 2009 (74 FR 52300). A full and exact description of all sDPS green sturgeon critical habitat, including excluded areas, can be found at 50 CFR 226.219. Critical habitat includes the stream channels and waterways in the Delta to the ordinary high water line. Critical habitat also includes the main stem Sacramento River upstream from the I Street Bridge to Keswick Dam, the Feather River upstream to the fish barrier dam adjacent to the Feather River Fish Hatchery, and the Yuba River upstream to Daguerre Dam. Coastal marine areas include waters out to a depth of 60 fathoms, from Monterey Bay in California, to the Strait of Juan de Fuca in Washington. Coastal estuaries designated as critical habitat include San Francisco Bay, Suisun Bay, San Pablo Bay, and the lower Columbia River estuary. Certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) are also included as critical habitat for sDPS green sturgeon.

Critical habitat for sDPS green sturgeon includes principal biological or physical constituent elements within the defined area that are essential to the conservation of the species. PCEs for sDPS green sturgeon have been designated for freshwater riverine systems, estuarine habitats, and nearshore coastal areas. In keeping with the focus on the California CV, we will limit our discussion to freshwater riverine systems and estuarine habitats.

Freshwater Riverine Systems

1. Food Resources

Abundant food items for larval, juvenile, subadult, and adult life stages for sDPS green sturgeon should be present in sufficient amounts to sustain growth, development, and support basic metabolism. Although specific information on food resources for green sturgeon within freshwater riverine systems is lacking, they are presumed to be generalists and opportunists that feed on similar prey as other sturgeons (Israel and Klimley 2008). Seasonally abundant drifting and benthic invertebrates have been shown to be the major food items of shovelnose and pallid sturgeon in the Missouri River (Wanner *et al.* 2007), lake sturgeon in the St. Lawrence River (Nilo *et al.* 2006), and white sturgeon in the lower Columbia River (Muir *et al.* 2000). As sturgeons grow, they begin to feed on oligochaetes, amphipods, smaller fish, and fish eggs as represented in the diets of lake sturgeon (Nilo *et al.* 2006), pallid sturgeon (Gerrity *et al.* 2006), and white sturgeon (Muir *et al.* 2000).

2. Substrate Type or Size

Critical habitat in the freshwater riverine system should include substrate suitable for egg deposition and development, larval development, subadults, and adult life stages. For example, spawning is believed to occur over substrates ranging from clean sand to bedrock, with preferences for cobble (Emmett *et al.* 1991, Moyle *et al.* 1995). Eggs are likely to adhere to substrates, or settle into crevices between substrates (Van Eenennaam *et al.* 2001, Deng *et al.* 2002). Larvae exhibited a preference for benthic structure during laboratory studies (Van Eenennaam *et al.* 2001, Deng *et al.* 2002, Kynard *et al.* 2005), and may seek refuge within crevices, but use flat-surfaced substrates for foraging (Nguyen and Crocker 2006).

3. Water Flow

An adequate flow regime is necessary for normal behavior, growth, and survival of all life stages in the upper Sacramento River. Such a flow regime should include stable and sufficient water flow rates in spawning and rearing reaches to maintain water temperatures within the optimal range for egg, larval, and juvenile survival and development (11°C - 19°C) (Mayfield and Cech 2004, Van Eenennaam *et al.* 2005, Allen *et al.* 2006). Sufficient flow is also needed to reduce the incidence of fungal infestations of the eggs, and to flush silt and debris from cobble, gravel, and other substrate surfaces to prevent crevices from being filled in and to maintain surfaces for feeding. Successful migration of adult green sturgeon to and from spawning grounds is also dependent on sufficient water flow. Spawning in the Sacramento River is believed to be triggered by increases in water flow to about 14,000 cfs [average daily water flow during spawning months: 6,900 – 10,800 cfs; Brown (2007)]. In Oregon's Rogue River, nDPS green sturgeon have been shown to emigrate to sea during the autumn and winter when water temperatures dropped below 10° C and flows increased (Erickson *et al.* 2002). On the Klamath River, the fall outmigration of nDPS green sturgeon has been shown to coincide with a significant increase in discharge resulting from the onset of the rainy season (Benson *et al* 2007). On the Sacramento River, flow regimes are largely dependent on releases from Shasta Dam, thus the operation of this dam could have profound effects upon sDPS green sturgeon habitat.

4. Water Quality

Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics are necessary for normal behavior, growth, and viability of all life stages. Suitable water temperatures would include: stable water temperatures within spawning reaches; temperatures within 11°C - 17°C (optimal range = 14°C - 16°C) in spawning reaches for egg incubation (March-August) (Van Eenennaam *et al.* 2005); temperatures below 20°C for larval development (Werner *et al.* 2007); and temperatures below 24°C for juveniles (Mayfield and Cech 2004, Allen *et al.* 2006). Suitable salinity levels range from fresh water (< 3 ppt) for larvae and early juveniles to brackish water (10 ppt) for juveniles prior to their transition to salt water. Prolonged exposure to higher salinities may result in decreased growth and activity levels and even mortality (Allen and Cech 2007). Adequate levels of dissolved oxygen (DO) are needed to support oxygen consumption by early life stages (ranging from 61.78 to 76.06 mg O_2 hr^{-1} kg^{-1} for juveniles, Allen and Cech (2007). Suitable water quality would also include water with acceptably low levels of contaminants (*i.e*., pesticides, organochlorines, selenium, elevated levels of heavy metals, *etc*.) that may disrupt normal development of embryonic, larval, and juvenile stages of green sturgeon. Poor water quality can have adverse effects on growth, reproductive development, and reproductive success. Studies on effect of water contaminants upon green sturgeon are needed; studies performed upon white sturgeon have clearly demonstrated the negative impacts contaminants can have upon white sturgeon biology (Foster *et al.* 2001a, 2001b, Feist *et al.* 2005, Fairey *et al.* 1997, Kruse and Scarnecchia 2002). Legacy contaminants such as mercury still persist in the watershed and pulses of pesticides have been identified in winter storm discharges throughout the Sacramento River basin, and the CV and Delta.

5. Migratory Corridor

Safe and unobstructed migratory pathways are necessary for adult green sturgeon to migrate to and from spawning habitats, and for larval and juvenile green sturgeon to migrate downstream from spawning and rearing habitats within freshwater rivers to rearing habitats within the estuaries. Unobstructed passage throughout the Sacramento River up to Keswick Dam (RM 302) is important, because optimal spawning habitats for green sturgeon are believed to be located upstream of the RBDD (RM 242).

6. Depth

Deep pools of ≥ 5 m depth are critical for adult green sturgeon spawning and for summer holding within the Sacramento River. Summer aggregations of green sturgeon are observed in these pools in the upper Sacramento River upstream of GCID. The significance and purpose of these aggregations are unknown at the present time, but may be a behavioral characteristic of green sturgeon. Adult green sturgeon in the Klamath and Rogue rivers also occupy deep holding pools for extended periods of time, presumably for feeding, energy conservation, and/or refuge from high water temperatures (Erickson *et al.* 2002, Benson *et al.* 2007). As described above approximately 54 pools with adequate depth have been identified in the Sacramento River upstream of the GCID location.

7. Sediment Quality

Sediment should be of the appropriate quality and characteristics necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of contaminants [*e.g.*, elevated levels of heavy metals (*e.g.*, mercury, copper, zinc, cadmium, and chromium), polycyclic aromatic hydrocarbons (PAHs), and organochlorine pesticides] that can result in negative effects on any life stage of green sturgeon or their prey. Based on studies of white sturgeon, bioaccumulation of contaminants from feeding on benthic species may negatively affect the growth, reproductive development, and reproductive success of green sturgeon. The Sacramento River and its tributaries have a long history of contaminant exposure from abandoned mines, separation of gold ore from mine tailings using mercury, and agricultural practices with pesticides and fertilizers which result in deposition of these materials in the sediment horizons in the river channel. The San Joaquin River is a source for many of these same contaminants, although pollution and runoff from agriculture are the predominant driving force. Disturbance of these sediment horizons by natural or anthropogenic actions can liberate he sequestered contaminants into the river. This is a continuing concern throughout the watershed.

For Estuarine Habitats

1. Food Resources

Abundant food items within estuarine habitats and substrates for juvenile, subadult, and adult life stages are required for the proper functioning of this PCE for green sturgeon. Green sturgeon feed primarily on worms, mollusks, and crustaceans (Moyle 2002). Radtke (1966) studied the diet of juvenile sDPS green sturgeon and found their stomach contents to include a mysid shrimp, amphipods, and other unidentified shrimp. These prey species are critical for the rearing, foraging, growth, and development of juvenile, subadult, and adult green sturgeon within the bays and estuaries. Currently, the estuary provides these food resources, although annual fluctuations in the population levels of these food resources may diminish the contribution of one group to the diet of green sturgeon relative to another food source.

Invasive species are a concern because they may replace the natural food items consumed by green sturgeon. The Asian overbite clam (*Corbula amurensis*) is one example of a prolific invasive clam species in the Delta. It has been observed to pass through white sturgeon undigested (Kogut 2008).

2. Water Flow

Within bays and estuaries adjacent to the Sacramento River (*i.e.*, the Delta and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds is required. Sufficient flows are needed to attract adult green sturgeon to the Sacramento River from the bay and to initiate the upstream spawning migration into the upper river. The specific quantity of flow required is a topic of ongoing research.

3. Water Quality

Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics, is necessary for normal behavior, growth and viability of all life stages. Suitable water temperatures for juvenile green sturgeon should be below 24°C (75°F). At temperatures above 24°C, juvenile green sturgeon exhibit decreased swimming performance (Mayfield and Cech 2004) and increased cellular stress (Allen *et al.* 2006). Suitable salinities in the estuary range from brackish water (10 ppt) to salt water (33 ppt). Juveniles transitioning from brackish to salt water can tolerate prolonged exposure to salt water salinities, but may exhibit decreased growth and activity levels (Allen and Cech 2007), whereas subadults and adults tolerate a wide range of salinities (Kelly *et al.* 2007). Subadult and adult green sturgeon occupy a wide range of DO levels, but may need a minimum DO level of at least 6.54 mg O_2/l (Kelly *et al.* 2007, Moser and Lindley 2007).

Suitable water quality also includes water free of contaminants (*e.g*., pesticides, organochlorines, elevated levels of heavy metals) that may disrupt the normal development of juvenile life stages, or the growth, survival, or reproduction of subadult or adult stages. In general, water quality in the Delta and estuary meets these criteria, but local areas of the Delta and downstream bays have been identified as having deficiencies. Discharges of agricultural drain water have also been implicated in local elevations of pesticides and other related agricultural compounds within the Delta and the tributaries and sloughs feeding into the Delta. Discharges from petroleum refineries in Suisun and San Pablo bay have been identified as sources of selenium to the local aquatic ecosystem (Linville *et al.* 2002).

4. Migratory Corridor

Safe and unobstructed migratory pathways are necessary for timely passage of adult, sub-adult, and juvenile fish within the region's different estuarine habitats and between the upstream riverine habitat and the marine habitats. Within the waterways comprising the Delta, and bays downstream of the Sacramento River, safe and unobstructed passage is needed for juvenile green sturgeon during the rearing phase of their life cycle. Passage within the bays and the Delta is also critical for adults and subadults for feeding and summer holding, as well as to access the Sacramento River for their upstream spawning migrations and to make their outmigration back into the ocean. Within bays and estuaries outside of the Delta and the areas comprised by Suisun, San Pablo, and San Francisco bays, safe and unobstructed passage is necessary for adult and subadult green sturgeon to access feeding areas, holding areas, and thermal refugia, and to ensure passage back out into the ocean. Currently, safe and unobstructed passage has been diminished by human actions in the Delta and bays. The CVP and SWP, responsible for large volumes of water diversions, alter flow patterns in the Delta due to export pumping and create entrainment issues in the Delta at the pumping and Fish Facilities. Power generation facilities in Suisun Bay create risks of entrainment and thermal barriers through their operations of cooling water diversions and discharges. Installation of seasonal barriers in the South Delta and operations of the radial gates in the Delta Cross Channel (DCC) facilities alter migration corridors available to green sturgeon. Actions such as the hydraulic dredging of ship channels and operations of large ocean going vessels create additional sources of risk to green sturgeon within the estuary. Commercial shipping traffic can result in the loss of fish, particularly adult fish, through ship and propeller strikes.

5. Water Depth

A diversity of depths is necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages. Subadult and adult green sturgeon occupy deep (≥ 5 m) holding pools within bays, estuaries, and freshwater rivers. These deep holding pools may be important for feeding and energy conservation, or may serve as thermal refugia (Benson *et al.* 2007). Tagged adults and subadults within the San Francisco Bay estuary primarily occupied waters with depths of less than 10 meters, either swimming near the surface or foraging along the bottom (Kelly *et al.* 2007). In a study of juvenile green sturgeon in the Delta, relatively large numbers of juveniles were captured primarily in shallow waters from 3 – 8 feet deep, indicating juveniles may require shallower depths for rearing and foraging (Radtke 1966).

Currently, there is a diversity of water depths found throughout the San Francisco Bay estuary and Delta waterways. Most of the deeper waters, however, are composed of artificially maintained shipping channels, which do not migrate or fluctuate in response to the hydrology in the estuary in a natural manner. Shallow waters occur throughout the Delta and San Francisco Bay. Extensive "flats" occur in the lower reaches of the Sacramento and San Joaquin river systems as they leave the Delta region and are even more extensive in Suisun and San Pablo bays. In most of the region, variations in water depth in these shallow water areas occur due to natural processes, with only localized navigation channels being dredged (*e.g.*, the Napa River and Petaluma River channels in San Pablo Bay).

6. Sediment Quality

Sediment quality (*i.e*., chemical characteristics) is necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of contaminants (*e.g*., elevated levels of selenium, PAHs, and organochlorine pesticides) that can cause negative effects on all life stages of green sturgeon (see description of *sediment quality* for riverine habitats above).

Summary of the Conservation Value of Green Sturgeon Critical Habitat

The current condition of critical habitat for the green sturgeon sDPS is degraded over its historical conditions. It does not provide the full extent of conservation values necessary for the survival and recovery of the species, especially in the upstream riverine habitat. In particular, passage and water flow PCEs have been impacted by human actions, substantially altering the historical river characteristics in which the green sturgeon sDPS evolved. The habitat values proposed for green sturgeon critical habitat have suffered similar types of degradation as described for winter-run Chinook salmon critical habitat. In addition, the alterations to the lower Sacramento River and delta Delta may have a particularly strong impact on the survival and recruitment of juvenile green sturgeon due to the protracted rearing time in the delta and estuary. Loss of individuals during this phase of the life history of green sturgeon represents losses to multiple year classes, which can ultimately impact the potential population structure for decades.

2.3 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

The environmental baseline describes the status of listed species and critical habitat in the action area, to which we add the effects of the West Sacramento GRS, to consider the effects of the proposed Federal actions within the context of other factors that impact the listed species. The effects of the proposed Federal action are evaluated in the context of the aggregate effects of all factors that have contributed to the status of listed species and, for non-Federal activities in the action area, those actions that are likely to affect listed species in the future, to determine if implementation of the West Sacramento GRS is likely to cause an appreciable reduction in the likelihood of both survival and recovery or result in destruction or adverse modification of critical habitat.

Reaches throughout the West Sacramento GRS planning area historically provided both shallow and deeper water habitat. Channel confining levees and upstream reservoirs that maintain year-round outflow have eliminated much of the adjacent shallow water floodplain habitat. Many native fish species are adapted to rear in flooded, shallow water areas that provide abundant cover and prey. As a consequence of habitat alterations, and the introduction of non-native species and pollutants, some native fish species are now extinct while most others are reduced in numbers (Moyle 2002).
A majority of the discussion in this BO will focus on the Sacramento River as the potential impacts to the Yolo Bypass, DWSC, Barge Canal, and Sacramento Bypass are minimal. This will be analyzed in the Effects section.

The Sacramento River watershed receives winter/early spring precipitation in the form of rain and snow (at higher elevations). Prior to the construction and operation of any reservoirs, winter rainfall events caused extensive flooding and spring snowmelt resulted in high flows during spring and early summer. Summer and fall flows were historically low. Currently, much of the total runoff is captured and stored in reservoirs for gradual release during the summer and fall months. High river flows occur during the winter and spring, but these are usually lower than during pre-European settlement times; summer and fall low flows are sustained by releases from upstream reservoirs.

The flood risk management system protecting the City of West Sacramento has been identified as insufficient by the Corps. According to the Corps, there is a high probability that flows in the American and Sacramento rivers will stress the network of levees protecting West Sacramento to the point that levees could fail. Failure of these levees could inundate highly urbanized areas up to 20 feet deep.

Sixteen land cover types were identified in the West Sacramento GRS project area. Nine of the land cover types are considered natural communities: all four riparian habitats, emergent marsh, valley oak woodland, walnut woodland, nonnative annual grassland, pond, and perennial drainage. The other cover types are associated with human activities: all three agricultural field types, walnut orchard, agricultural ditch, and developed/landscaped.

Despite the impaired status of the Sacramento River in the proposed project action area, the value of the lower Sacramento River as a migratory corridor for CV spring-run Chinook salmon, CCV steelhead, Sacramento River winter-run Chinook salmon, and sDPS green sturgeon is high primarily because it contains habitat elements that support the rearing and growth of juveniles and the successful upstream migration of adults. The West Sacramento GRS will occur downstream of the confluence of major watersheds, including the American, Yuba, and Feather river and watersheds further upstream such as Butte Creek and Battle Creek. Thus, the action area is also within the migratory corridor for the fish that utilize all the aforementioned watersheds.

Anticipated climate change may affect spatial and temporal precipitation patterns along with the intensity and duration of precipitation within the Sacramento River watershed. The effect of climate change is anticipated to be more winter and less spring and summer run-off within the watershed. In addition, expected run-off is anticipated to be warmer, possibly affecting the ability to meet downstream water temperature objectives to protect salmon, steelhead, and green sturgeon. This combined with more precipitation as rain will affect future operations of all reservoirs within the California CV. A change in the run-off pattern within the Sacramento River watersheds will likely affect reservoir storage and downstream river flows due to more frequent spillway releases.

This same flood management system impacts the natural meander and ecosystem of the Sacramento River. The West Sacramento Project study area includes the mainstem Sacramento River 11.4 miles from the Sacramento Bypass south to the South Cross Levee. The proposed project area also includes the Yolo Bypass, DWSC, Barge Canal, Port of West Sacramento, upper Yolo Bypass toe drain, and the South Cross toe drain. Downstream from the American River confluence, the Sacramento River is moderately sinuous, with the channel confined on both sides by levees enhanced by decades of additions. The channel in this reach is of uniform width, is not able to migrate, and is typically narrower and deeper relative to the upstream reach due to scour caused by the concentration of shear forces acting against the channel bed (Brice 1977). There is a short reach of setback levee in this reach, on the west bank of the Sacramento River at RM 57.2. The setback levee at RM 57.2 was constructed by the Corps under the SRBPP.

The natural banks and adjacent floodplains of the Sacramento River are composed of silt-to gravel-sized particles with poor to high permeability. Historically, the flow regimes caused the deposition of a gradient of coarser to finer material, and longitudinal fining directed downstream (sand to bay muds). The deposition of these alluvial soils historically accumulated to form extensive natural levees and splays along the river, 5 to 20 feet above the floodplain for as far as

10 miles from the channel (Thompson 1961). The present day channels consist of fine-grained cohesive banks that erode due to natural processes as well as high flow events (Corps 2012).

Seasonal high flows enter the adjacent Yolo Bypass from this reach of the Sacramento River via the Sacramento Bypass. Tidal influence emanating from Suisun Bay extends up the Sacramento River for 80 miles to Verona, with greater tidal variations occurring downstream during low river stages in summer and fall.

The West Sacramento Project study area consists of primarily riparian scrub-shrub habitat. Early riparian habitat may be called scrub-shrub. Scrub-shrub generally refers to areas where the woody riparian canopy is composed of trees or shrubs approximately 20 feet high. Species that are typically found in these habitats include young cottonwood (*Populus trichocarpa*), willow (*Salix spp.*), elderberry (*Sambucus spp.*), buttonbush (*Cephalanthus occidentalis*), Himalaya blackberry (*Rubus armeniacus*), wild grape (*Vitis vinifera*), and poison oak (*Toxicodendron spp.*).

Riparian forest typically has a dominant overstory of cottonwood, California sycamore (*Platanus racemosa*), or valley oak (*Quercus lobata*). Species found in the scrub-shrub will make up the sub canopy and could also include white alder and box elder. Layers of climbing vegetation make up part of the subcanopy, with wild grape being a major component, but wild cucumber and clematis are also found in riparian communities.

The herbaceous ruderal habitat is found on most levees along the Sacramento River. It occurs on the levees and also within gaps in the riparian habitats. Plant species include wild oats (*Avena spp.*), soft chess (*Bromus hordeaceus*), ripgut brome (*Bromus hordeaceus*), red brome (*Bromus madritensis*), wild barley (*Bromus hordeaceus)*, and foxtail fescue (*Festuca megalura*). Common forbs include broadleaf filaree (*Erodium spp.*), red stem filaree (*Erodium spp.*), turkey mullein (*Eremocarpus setigerus*), clovers (*Trifolium spp.*), and many others. The majority of these plants are not native to the project area.

Riparian recruitment and establishment models (Mahoney and Rood 1998; Bradley and Smith 1986) and empirical field studies (Scott et al. 1997, 1999) emphasize that hydrologic and fluvial processes play a central role in controlling the elevational and lateral extent of riparian plant species. These processes are especially important for pioneer species that establish in elevations close to the active channel, such as cottonwood and willows (*Salix* spp.). Failure of cottonwood recruitment and establishment is attributed to flow alterations by upstream dams (Roberts et al. 2001) and to isolation of the historic floodplain from the river channel. In addition, many of these formerly wide riparian corridors are now narrow and interrupted by levees and weirs. Finally, draining of wetlands, conversion of floodplains to agricultural fields, and intentional and unplanned introduction of exotic plant species have altered the composition and associated habitat functions of many of the riparian communities that are able to survive under current conditions.

A key element of the environmental baseline is the construction of the Southport EIP which will occur between 2015 and 2021. The project will include a 1,900 foot long set-back levee, the breaching of the existing levee, and the seasonal inundation and restoration of approximately 120 acres of historic floodplain habitat.

Although there are some short-term and small SAM modeled WRI deficits associated with Southport, the effects of these deficits are small, occur during seasons when fish abundance is low or they are not present at all, and is of short duration. In the case of fry and juvenile rearing and migration for all species, the SAM modeled WRI values show significant increases in the growth and survival of individuals, such that the incremental effects of the action are not expected to increase the extinction risk of the Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon and ESU CCV steelhead and green sturgeon DPS or reduce the conservation value of their designated critical habitat.

Furthermore, at the Southport EIP, the anticipated growth and survival of salmon, steelhead and green sturgeon rearing and juvenile migration are substantially positive and demonstrate how integrating NMFS high priority recovery actions, such as setback levee construction and restoration of floodplain habitat can contribute to an increase in the production and abundance of the Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon and ESU CCV steelhead and green sturgeon DPS.

2.3.1 Status of the Species in the Action Area

The action area, which encompasses portions of the lower Sacramento River, the DWSC, Port of West Sacramento, and the Sacramento and Yolo bypasses, and associated floodplains and riparian areas at and adjacent to the proposed construction sites functions as a migratory corridor for CV spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, CCV steelhead, and sDPS of North American green sturgeon. The action area is also used for rearing and adult feeding.

1. <u>Presence of CCV Steelhead in the Action Area</u>

The CCV steelhead DPS final listing determination was published on January 5, 2006 (71 FR 834) and included all naturally spawned populations of steelhead (and their progeny) downstream of natural and manmade barriers in the Sacramento and San Joaquin rivers and their tributaries. FRFH steelhead are also included in this designation. All adult CCV steelhead originating in the Sacramento River watershed will have to migrate through the action area in order to reach their spawning grounds and to return to the ocean following spawning. Likewise, all CCV steelhead smolts originating in the Sacramento River watershed will also have to pass through the action area during their emigration to the ocean. The waterways in the action area also are expected to provide some rearing benefit to emigrating steelhead smolts. The CCV steelhead DPS occurs in both the Sacramento River and the San Joaquin River watersheds. However the spawning population of fish is much greater in the Sacramento River watershed and accounts for nearly all of the DPS' population.

CCV steelhead smolts will first start to appear in the action area in November. This is based on the records from the CVP and SWP fish salvage facilities, as well as the fish monitoring program in the northern and central Delta. Their presence increases through December and January, peaks in February and March, and declines in April. By June, the emigration has essentially ended, with only a small number of fish being salvaged through the summer at the CVP and SWP. Adult steelhead are expected to move through the action area throughout the year with the peak of upriver immigration expected to occur August through November. There is potential exposure to adult steelhead moving back downstream in a post-spawn condition (kelts) through the action area during the February to May period. It is expected that more kelts will be observed earlier in the period (February) due to the timing of spawning in the Sacramento River basin.

Based on the temporal presence of adult and juvenile steelhead in the lower Sacramento River, the timing of the proposed project, and the location of the action area, it is likely that adult steelhead will be using the action area as a migration corridor during construction. Additionally, it is likely that juvenile steelhead may be emigrating through the action area during construction. Depending on the water year type and the timing of high flows in the Sacramento River basin, adult and/or juvenile CCV steelhead may be present in the Yolo Bypass and the Sacramento Bypass. It is possible that any CCV steelhead (particularly adults) that are in the Delta may enter into the DWSC and the subsidiary bays.

2. Presence of CV spring-run Chinook salmon in the Action Area

A similar application of the CVP and SWP salvage records and the northern and Central Delta fish monitoring data to the presence of CV spring-run Chinook salmon indicates that juvenile spring-run Chinook salmon first begin to appear in the action area in December and January, but that a significant presence does not occur until March and peaks in April. By May, the salvage of juvenile CV spring-run Chinook salmon declines sharply and essentially ends by the end of June. The data from the northern and central Delta fish monitoring programs indicate that a small proportion of the annual juvenile spring-run emigration occurs in January and is considered to be mainly composed of older yearling spring-run juveniles based on their size at date. Adult spring-run Chinook salmon are expected to start entering the action area in approximately January. Low levels of adult migration are expected through early March. The peak of adult spring-run Chinook salmon movement through the action area is expected to occur between April and June with adults continuing to enter the system through the summer. Currently, all known populations of CV spring-run Chinook salmon inhabit the Sacramento River watershed.

Based on the temporal presence of CV spring-run Chinook salmon in the lower Sacramento River, the timing of the proposed project, and the location of the action area, it is likely that adult and juvenile CV spring-run Chinook salmon will be using the action area. Depending on the water year type and the timing of high flows in the Sacramento River basin, adult and/or juvenile CV spring-run Chinook salmon may be present in the Yolo Bypass and the Sacramento Bypass. It is possible that any CV spring-run Chinook salmon (particularly adults) that are in the Delta may enter into the DWSC and the subsidiary bays.

3. Presence of Sacramento River winter-run Chinook salmon in the Action Area

The temporal occurrence of Sacramento River winter-run Chinook salmon smolts and juveniles within the action area are best described by a combination of the salvage records of the CVP and SWP fish collection facilities and the fish monitoring programs conducted in the northern and central Delta. Based on salvage records at the CVP and SWP fish collection facilities, juvenile Sacramento River winter-run Chinook salmon are expected in the actions area starting in December. Their presence peaks in March and then rapidly declines from April through June. The majority of winter-run juveniles will enter the action area during February through June. Presence of adult Chinook salmon is interpolated from historical data. Adult winter-run Chinook salmon are expected to enter the action area starting in January, with the majority of adults passing through the action area between February and April.

Based on the temporal presence of Sacramento River winter-run Chinook salmon in the lower Sacramento River, the timing of the proposed project, and the location of the action area, it is likely that adult and juvenile Sacramento River winter-run Chinook salmon will be using the action area. Depending on the water year type and the timing of high flows in the Sacramento River basin, adult and/or juvenile Sacramento River winter-run Chinook salmon may be present in the Yolo Bypass and the Sacramento Bypass. It is possible that any Sacramento River winter-run Chinook salmon (particularly adults) that are in the Delta may enter into the DWSC and the subsidiary bays.

4. Presence of North American green sturgeon in the Action Area

The Sacramento River is an important migratory corridor for larval and juvenile sturgeon during their downstream migration to the San Francisco Bay Delta and Estuary. The San Francisco Bay Delta and Estuary provides year-round rearing habitat for juveniles, as well as foraging habitat for non-spawning adults and subadults in the summer months (NMFS 2008).

Detailed information regarding historic and current abundance, distribution and seasonal occurrence of North American green sturgeon in the action area is limited due to a general dearth of green sturgeon monitoring. The action area is located on the main migratory route for adults moving upstream to spawn, post spawn adults migrating back to the ocean, juvenile outmigrants, and rearing subadults. Juvenile green sturgeon from the sDPS are routinely collected at the SWP and CVP salvage facilities throughout the year. Based on the salvage records, green sturgeon may be present during any month of the year, and have been particularly prevalent during July and August. Adult green sturgeon begin to enter the Delta in late February and early March during the initiation of their upstream spawning run. The peak of adult entrance into the Delta appears to occur in late February through early April with fish arriving upstream in April and May. Adults continue to enter the Delta until early summer (June-July) as they move upriver to spawn. It is also possible that some adult green sturgeon will be moving back downstream in April and May through the action area, either as early post spawners or as unsuccessful spawners. Some adult green sturgeon have been observed to rapidly move back downstream following spawning, while others linger in the upper river until the following fall. It is possible that any of the adult or sub-adult sturgeon that inhabit the Delta may swim into the DWSC.

Similar to the salmonid species, depending on the water year type, it is possible that sturgeon will enter the Sacramento and Yolo bypass.

2.3.2 Status of Critical Habitat within the Action Area

The action area occurs within the CALWATER Hydrologic Unit (HU) for the Sacramento Delta Subbasin, designated HU 5510. Designated critical habitat for Sacramento River winter-run Chinook salmon (June 16, 1993, 58 FR 33212), CV spring-run Chinook salmon (September 2, 2005, 70 FR 52488), CCV steelhead (September 2, 2005, 70 FR 52488) and the sDPS of green sturgeon (October 9, 2009, 74 FR 52300) occur in this hydrologic unit. The HU includes portions of the Sacramento River and the DWSC. The critical habitat analytical review team (CHART) concluded that it contained one or more PCEs for both the CCV steelhead DPS and CV spring-run Chinook salmon ESU (NMFS 2005). The PCEs for steelhead and spring-run Chinook salmon habitat within the action area include freshwater rearing habitat and freshwater migration corridors. The features of the PCEs included essential to the conservation of the CCV steelhead DPS and CV spring-run Chinook salmon include the following: sufficient water quantity and floodplain connectivity to form and maintain physical habitat conditions necessary for salmonid development and mobility, sufficient water quality, food and nutrients sources, natural cover and shelter, migration routes free from obstructions, no excessive predation, holding areas for juveniles and adults, and shallow water areas and wetlands. Habitat within the action area is primarily utilized for freshwater rearing and migration by CCV steelhead and CV spring-run Chinook salmon juveniles and smolts and for adult freshwater migration. No spawning of CCV steelhead or CV spring-run Chinook salmon occurs within the action area.

Critical habitat for winter-run Chinook salmon includes the Sacramento River reach within the action area. Critical habitat elements include the river water, river bottom, and adjacent riparian zone used by fry and juveniles for rearing. Downstream migration of juveniles and upstream migration of adults should not be impeded or blocked. Adequate forage base is required to provide food for emigrating juvenile winter-run.

In regards to the designated critical habitat for the sDPS of green sturgeon, the action area includes PCEs concerned with: adequate food resources for all life stages; water flows sufficient to allow adults, subadults, and juveniles to orient to flows for migration and normal behavioral responses; water quality sufficient to allow normal physiological and behavioral responses; unobstructed migratory corridors for all life stages; a broad spectrum of water depths to satisfy the needs of the different life stages present in the estuary; and sediment with sufficiently low contaminant burdens to allow for normal physiological and behavioral responses to the environment.

The general condition and function of the aquatic habitat has already been described in the *Status of the Species and Critical Habitat* section of this BO. The substantial degradation over time of several of the essential critical elements has diminished the function and condition of the freshwater rearing and migration habitats in the action area. It has only rudimentary functions compared to its historical status. The channels of the lower Sacramento River have been riprapped with coarse stone slope protection on artificial levee banks and these channels have been straightened to enhance water conveyance through the system. The extensive riprapping and levee construction has precluded natural river channel migrations. The natural floodplains have essentially been eliminated, and the once extensive wetlands and riparian zones have been "reclaimed" and subsequently drained and cleared for farming.

Even though the habitat has been substantially altered and its quality diminished through years of human actions, its conservation value remains high for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon. All juvenile winter-run and spring-run Chinook salmon, sDPS green sturgeon, as well as those CCV steelhead smolts originating in the Sacramento River basin must pass into and through the Sacramento Delta HU to reach the lower Delta and the ocean. A large fraction of these fish will likely pass downstream through the action area within the Sacramento River channel. Likewise, adults migrating upstream to spawn must pass through Sacramento Delta HU to reach their upstream spawning areas on the tributary watersheds or main stem Sacramento River. A large proportion of the population is expected to move through the action area within the main channel of the Sacramento River. Therefore, it is of critical importance to the long-term viability of the Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon ESUs, the sDPS of green sturgeon, and the Sacramento River basin portion of the CCV steelhead DPS to maintain a functional migratory corridor and freshwater rearing habitat through the action area and the Sacramento Delta subbasin HU in general.

2.3.4 Factors Affecting the Species and Habitat in the Action Area

The action area encompasses a small portion of the area utilized by the Sacramento River winter-run and CV spring-run Chinook salmon ESUs, and the CCV steelhead DPS as well as the sDPS of North American green sturgeon. Many of the factors affecting these species throughout their range are discussed in the *Rangewide Status of the Species and Critical Habitat* section of this BO, and are considered the same in the action area. This section will focus on the specific factors in the action area that are most relevant to the proposed project.

The magnitude and duration of peak flows during the winter and spring are reduced by water impoundment in upstream reservoirs affecting listed salmonids in the action area. Instream flows during the summer and early fall months have increased over historic levels for deliveries of municipal and agricultural water supplies. Overall, water management now reduces natural variability by creating more uniform flows year-round. Current flood control practices require peak flood discharges to be held back and released over a period of weeks to avoid overwhelming the flood control structures downstream of the reservoirs (*i.e.* levees and bypasses). Consequently, managed flows in the main stem of the river often truncate the peak of the flood hydrograph and extended the reservoir releases over a protracted period. These actions reduce or eliminate the scouring flows necessary to mobilize gravel and clean sediment from the spawning reaches of the river channel.

High water temperatures also limit habitat availability for listed salmonids in the lower Sacramento River. High summer water temperatures in the lower Sacramento River can exceed 72^{o}F (22.2^{o}C), and create a thermal barrier to the migration of adult and juvenile salmonids (Kjelson *et al*. 1982). In addition, water diversions at the dams (*i.e.* Friant, Goodwin, La Grange, Folsom, Nimbus, and other dams) for agricultural and municipal purposes have reduced in-river flows below the dams. These reduced flows frequently result in increased temperatures during the critical summer months which potentially limit the survival of juvenile salmonids in these tailwater sections (Reynolds *et al*. 1993). The elevated water temperatures compel many salmon juveniles to migrate out of the valley floor systems before summer heat makes the tailwaters unsuitable for salmonids. Those fish that remain either succumb to the elevated water temperatures or are crowded into river reaches with suitable environmental conditions.

Levee construction and bank protection have affected salmonid habitat availability and the processes that develop and maintain preferred habitat by reducing floodplain connectivity, changing riverbank substrate size, and decreasing riparian habitat and shaded riverine aquatic (SRA) cover. Individual bank protection sites typically range from a few hundred to a few thousand linear feet in length. Such bank protection generally results in two levels of impacts to the environment: (1) site-level impacts which affect the basic physical habitat structure at individual bank protection sites; and (2) reach-level impacts which are the accumulative impacts to ecosystem functions and processes that accrue from multiple bank protection sites within a given river reach. Revetted embankments result in loss of sinuosity and braiding and reduce the amount of aquatic habitat. Impacts at the reach level result primarily from halting erosion and controlling riparian vegetation. Reach-level impacts which cause significant impacts to fish are reductions in new habitats of various kinds, changes to sediment and organic material storage and transport, reductions of lower food-chain production, and reduction in large woody debris (LWD).

The use of rock armoring limits recruitment of LWD (*i.e.*, from non-riprapped areas), and greatly reduces, if not eliminates, the retention of LWD once it enters the river channel. Riprapping creates a relatively clean, smooth surface which diminishes the ability of LWD to become securely snagged and anchored by sediment. LWD tends to become only temporarily snagged along riprap, and generally moves downstream with subsequent high flows. Habitat value and ecological functioning aspects are thus greatly reduced, because wood needs to remain in place to generate maximum values to fish and wildlife. Recruitment of LWD is limited to any eventual, long-term tree mortality and whatever abrasion and breakage may occur during high flows. Juvenile salmonids are likely being impacted by reductions, fragmentation, and general lack of connectedness of remaining near shore refuge areas.

Point and non-point sources of pollution resulting from agricultural discharge and urban and industrial development occur upstream of, and within the action area. The effects of these impacts are discussed in detail in the *Rangewide Status of the Species and Critical Habitat* section. Environmental stressors as a result of low water quality can lower reproductive success and may account for low productivity rates in fish (*e.g.* green sturgeon, Klimley 2002). Organic contaminants from agricultural drain water, urban and agricultural runoff from storm events, and high trace element (*i.e.* heavy metals) concentrations may deleteriously affect early life-stage survival of fish in the Sacramento River (USFWS 1995). Principle sources of organic contamination in the Sacramento River are rice field discharges from Butte Slough, Reclamation District 108, Colusa Basin Drain, Sacramento Slough, and Jack Slough (USFWS 1995). Other impacts to adult migration present in the action area, such as migration barriers, water conveyance factors, water quality, NIS, *etc.*, are discussed in the *Rangewide Status of the Species and Critical Habitat* section.

As previously stated in the *Rangewide Status of the Species and Critical Habitat* section, the transformation of the Sacramento River from a meandering waterway lined with a dense riparian corridor, to a highly leveed system under varying degrees of control over riverine erosional processes resulted in homogenization of the river, including effects to the rivers sinuosity. These impacts likely included the removal of valuable pools and holding habitat for North American green sturgeon. In addition, the change in the ecosystem as a result of the removal of riparian vegetation and LWD likely reduce access to floodplain and offchannel rearing habitat, reduced the quantity and quality of benthic habitat and reduced the abundance prey items rearing, foraging and holding habitat. A major factor in the decline of sDPS green sturgeon, and the primary reason for listing this species, was the alteration of its adult spawning and larval rearing habitat in California's Sacramento River Basin (71 FR 17757, April 7, 2006).

2.4 Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

To evaluate the effects of the West Sacramento GRS, NMFS examined the potential proposed actions in the designated action areas. We analyzed construction-related impacts and the expected short- and long-term fish response to habitat modifications using the SAM. We also reviewed and considered the Corps proposed conservation measures. This assessment relied heavily on the information from the Corps BA developed for the West Sacramento GRS, and available monitoring data from other CV fish studies.

In general, the footprint for the West Sacramento Project consists of the flood risk management system protecting the city of West Sacramento and surrounding areas. This will include structure upgrades, levee deconstruction, and adjacent staging areas. The continued existence of any new or improved flood management structures, associated critical habitat disturbance, vegetation removal, and operational aspects may adversely affect several life stages of CV spring-run Chinook salmon, CCV steelhead, Sacramento River winter-run Chinook salmon, and the sDPS of North American green sturgeon in the action area.

The assessment will consider the nature, duration, and extent of the potential actions relative to the migration timing, behavior, and habitat requirements of federally listed CV spring-run Chinook salmon, CCV steelhead, Sacramento River winter-run Chinook salmon, and sDPS of North American green sturgeon. Specifically, this assessment will consider the potential impacts resulting from the construction and subsequent O&M activites. Effects of the West Sacramento Project on aquatic resources include both short- and long-term impacts. Short-term effects, which are related primarily to construction activities (*i.e.*, increased suspended sediment and turbidity), may last several hours to several weeks. Long-term impacts may last months or years and generally involve physical alteration of the river bank and riparian vegetation adjacent to the water's edge.

The West Sacramento Project construction activities may increase noise, turbidity, suspended sediment, and sediment deposition that may disrupt feeding or temporarily displace fish from preferred habitat or impair normal behavior. Construction activities will also introduce rip rap material into the water column that may injure, harm, or kill listed fish. Some of these effects may occur downstream of the construction activities because noise and sediment may be propagated downstream. Substantial increases in suspended sediment could temporarily bury substrates and submerged aquatic vegetation that supports invertebrates for feeding juvenile fish.

The bank armoring and some of the levee repairs will also contribute to the continued confinement of the riverine system that in turn negatively impacts listed fish species and their designated critical habitat. Even with an ETL variance in place, adopting the ETL as part of the proposed project may have long-term impacts to critical habitat and listed species. Additionally, despite the assumption of a variance, there are uncertainties as to the subsequent O&M activities and their impacts.

Since specific project designs were not available at the time of this analysis, impacts are characterized using "worst case scenario" assumptions. With-project conditions were assumed to be analogous a typical SRBPP repair site (bank armoring paired with onsite restoration features including a planted riparian bench and installed IWM). A Vegetation Variance Request (VVR) was assumed to be in place. Project actions along the Yolo Bypass, Sacramento Bypass, and DWSC, Port North, and Port South reaches, including slurry wall construction, slope stabilization, and levee raises were assumed to result in removal of all woody and herbaceous vegetation and armoring of both summer-fall and winter-spring shorelines.

The West Sacramento project reach will be implemented in increments. The timing of each project sub-reach (Table 3) is based on the proposed schedule provided in the BA (USACE 2014). Some of the project increments will be of varying length, thereby impacting the subsequent analysis.

2.4.1 Construction Related Effects

NMFS expects that adult and juvenile CCV steelhead, adult winter-run Chinook salmon, adult spring-run Chinook salmon, and adult and juvenile green sturgeon may be present in the action area (although in low numbers because the construction window avoids periods of peak abundance) during construction activities. Only those fish that are holding adjacent to or migrating past the Southport EIP sites will be directly exposed or affected by construction activities. Those fish that are exposed to the effects of construction activities will encounter short-term (*i.e.*, minutes to hours) construction-related noise, physical disturbance, and water quality changes that may cause injury or harm by increasing the susceptibility of some individuals to predation by temporarily disrupting normal behaviors, and affecting sheltering abilities. If an adult salmonid were to enter the action area, they will likely exhibit avoidance behavior in response to construction and associated activities.

Larger fish will likely respond to construction activities by quickly swimming away from the construction sites, and will escape injury. Toxic substances used at construction sites, including gasoline, lubricants, and other petroleum-based products could enter the waterway as a result of spills or leakage from machinery and injure listed salmonids, and green sturgeon. Petroleum products also tend to form oily films on the water surface that can reduce DO available to aquatic organisms. NMFS expects that adherence to BMPs that dictate the use, containment, and cleanup of contaminants will minimize the risk of introducing such products to the waterway.

Green sturgeon move to estuaries and the lower reaches of rivers between late winter and early summer, and ascend rivers to spawn in the spring and early summer. Adult green sturgeon may leave the rivers soon after spawning or hold in the river through the fall or winter (Heublein et al. 2009). Movement and foraging during downstream migration occurs at night for both larvae (approximately 10 days post-hatch) and juveniles (73 FR 52084; Cech *et al*. 2000, as cited in Reclamation 2008). Juvenile emigration reportedly occurs from May through September. Juvenile will experience the greatest exposure to construction activities.

Direct effects are defined as "the direct or immediate effects of the Proposed Action on the species or its habitat" (USFWS and NMFS, March 1998). Direct effects associated with in-river construction work will involve equipment and activities that will produce pressure waves, and create underwater noise and vibration, thereby temporarily altering in-river conditions.

Any increases in turbidity will most likely disrupt feeding and migratory behavior activities of juvenile salmonids (though their abundance is expected to be low). Turbidity and sedimentation events are not expected to affect visual feeding success of green sturgeon, as they are not believed to utilize visual cues (Sillman *et al.* 2005). Green sturgeon, which can occupy waters containing variable levels of suspended sediment and thus turbidity, are not expected to be impacted by the slight increase in the turbidity levels anticipated from the pile driving action as explained above. The construction activities are unlikely to impact any deepwater areas where the species spawn and hold.

NMFS expects that actual physical damage or harassment to listed fish species will be low during the months of construction. Adults will not sustain any physical damage due to construction because their size, preference for deep water, and their crepuscular migratory behavior will enable them to avoid most temporary, nearshore disturbance that occurs during typical daylight construction hours.

2.4.2 Standard Assessment Methodology Analysis

West Sacramento Project impacts were analyzed using SAM. The Corps provided the background data, assumptions, analyses, and assessment of habitat compensation requirements for the federally protected fish species relevant to this consultation. The Corps also included analysis for fall-run and late-fall run Chinook salmon.

The Sacramento River SAM analysis reach includes the entire right bank (west side) of the Sacramento River from the Sacramento Bypass to the confluence of the Sacramento River and the old Stone Locks near the Port of Sacramento. This reach also includes the short cut-off levee described as part of the Port South phase of the project. The response of all runs of Chinook salmon, steelhead, and green sturgeon were included in the analysis of this reach.

As described in the *Analytical* Approach section of the BO, during the process of this consultation, the Corps and NMFS identified several short comings with the SAM as a tool for reliably forecasting the growth and survival of green sturgeon. The primary short coming is that the SAM evaluates habitat conditions at the seasonal water surface intersect with the river bank. While this is considered an effective point for measuring salmon and steelhead habitat, green sturgeon have a greater affinity for benthic habitat than shoreline habitat. Further, during discussions between the Corps and NMFS, it was widely agreed upon that levee repair actions in the West Sacramento Study Area are likely to only affect the juvenile rearing life stage and probably have little to no adverse impacts on the adult life stages of green sturgeon because spawning habitat is not present and adults that are migrating upstream are probably more influenced by impacts that affect swimming speed and upstream passage than shoreline habitat manipulations. Because of this, NMFS has decided to use the SAM as a temporary proxy for quantifying habitat disturbance and harm that will ultimately be replaced by a more precise model as proposed by the Corps in the *Proposed Action* section of this BO.

The following data sources were used to characterize SAM habitat conditions (as defined by bank slope, floodplain availability, substrate size, instream structure, aquatic vegetation, and overhanging shade) within the West Sacramento Project area under baseline conditions:

1. The Corps' Sacramento River revetment database.
2. Aerial images of the West Sacramento Project reach (Google™ Earth).

The SAM employs six habitat variables to characterize near-shore and floodplain habitats of listed fish species:

1. Bank slope;
2. Floodplain availability;
3. Bank substrate size;
4. Instream structure;
5. Aquatic vegetation; and
6. Overhanging shade.

The following describes how input values for each of these attributes were derived for existing conditions in the SAM assessment.

1. **Bank Slope:** Existing bank slopes (rise-over-run ratio) were extrapolated from cross sections along the Sacramento River and existing SAM analyses performed on regionally analogous sites. Bank slope along all sub-reaches was assumed to be 2.5 for existing conditions.

2. **Floodplain Availability:** The SAM attribute of floodplain inundation ratio, which represents floodplain availability, was assumed to have a value of 1, reflecting the absence of significant floodplain habitat above the winter-spring shoreline under existing conditions.

3. **Bank Substrate Size:** The median substrate size along the summer-fall and winter-spring shorelines of the project reach was determined by referencing the Revetment Database (USACE 2004) and current and historical aerial images.

4. **Instream Structure:** The shoreline coverage of IWM along the average summer-fall and winter-spring shorelines of the West Sacramento project reach were determined by referencing the revetment database (USACE 2004). The revetment database uses four classes of instream structure, based on ranges of percent shoreline having IWM.

5. **Overhanging Shade:** The extent of overhanging shade along the summer-fall and winter-spring shorelines was determined through analysis of current and historic aerial images. Summer-fall conditions were analyzed using imagery from late summer and early fall months, typically representative of low water conditions. Winter-spring conditions were analyzes using imagery from late winter and early spring months, typically representative of high water conditions.

The following describes how input values for each of the SAM habitat attributes were derived for with-project conditions:

1. **Bank Slope:** With-project bank slopes (rise-over-run ratio) were based on the description of project actions for each sub-reach. Bank slopes for the SAC sub-reach were assumed to be analogous to SRBPP repair sites.

2. **Floodplain Availability:** Levee repair and bank stabilization actions typically do not increase floodplain availability (with exception of constructing setback levees). The West Sacramento project reaches being analyzed under this SAM do not include construction of any setback levees; therefore, the SAM attribute of floodplain inundation ratio, which represents floodplain availability, was assumed to lack significant floodplain habitat above the winter-spring shoreline under existing conditions.

3. **Bank Substrate Size:** The median substrate size along the summer-fall and winter-spring shorelines of the project reach were based on the description of project actions for each reach. Bank substrate size along the Sacramento River reach was assumed to be analogous to SRBPP repair sites. Project actions at all other sub-reaches were expected to result in placement of 10 inch rock revetment along both summer-fall and winter-spring shorelines.

4. **Instream Structure:** The shoreline coverage of IWM along the average summer-fall and winter-spring shorelines was based on the description of project actions for each sub-reach. IWM coverage along the SAC sub-reach was assumed to be analogous to SRBPP repair sites (installation of 40 percent shoreline coverage at summer-fall shoreline). Project actions at all other sub-reaches were not expected to result in a change in available IWM along both summer-fall and winter-spring shorelines; IWM values for these sub-reaches will mirror existing condition values.

5. **Aquatic Vegetation:** The shoreline coverage of aquatic vegetation along the average summer-fall and winter-spring shorelines was based on the description of project actions for each sub-reach. Aquatic vegetation along the Sacramento River was assumed to be analogous to SRBPP repair sites. The vegetation growth model below

that was applied to the Sacramento River was taken from a previous SAM analysis conducted for Sacramento RM 62.5R (USACE 2008).

6. **Overhanging Shade:** The shoreline coverage of overhanging shade along the average summer-fall and winter-spring shorelines was based on the description of project actions for each sub-reach. Overhanging shade along the Sacramento River was assumed to be analogous to SRBPP repair sites. It was assumed that a variance will be in place allowing for retention of woody vegetation along the lower 2/3 of the levee slope (applies to Sacramento River only). As the result of constructing a planted bench, it was assumed that the with-project seasonal shoreline will be shifted away from the existing shade providing canopy. Under this assumption, existing summer-fall values for overhanging shade were taken as the starting point for with-project winter-spring conditions. The with-project winter-spring values were further reduced by 75 percent (winter) and 25 percent (spring) to account for defoliation. As a final step, these winter-spring values were reduced by 20 percent to account for trees removed for construction equipment access. With-project overhanging shade values were expected to start at 0 percent as the result of a constructed bench shifting the shoreline away from the existing canopy. The shade growth model used was taken from a previous SAM analysis conducted for Sacramento RM 62.5R (USACE 2008).

Project actions at all other sub-reaches were expected to result in a complete removal of woody vegetation without revegetation efforts. For these sub-reaches, a value of 0 percent shoreline coverage of overhanging shade was applied throughout the life of the project along both summer-fall and winter-spring shorelines.

Portions of the proposed project area were excluded from the SAM analysis. The South Cross levee was excluded because it lacked hydrologic connectivity to the surrounding river and does not provide fish habitat. Several portions of the DWSC, Port South Levee, and Port North Levee were excluded because the levees are set back from the shoreline and project actions are not expected to affect shoreline habitat. A portion of the lower Sacramento River, immediately north of the Southport EIP portion of the project, was excluded because it is currently being repaired as part of the SRBPP. For more information on the SAM analysis, refer to the Appendix G of the BA (Corps 2014).

2.4.3 SAM Results

The SAM results presented below and in Table 10 and 11 are based on a “worst case scenario” analysis, as developed by the Corps. Table 10 and 11 show negative WRI values, but there are several areas where the action will result in improved conditions for salmon and steelhead. These are discussed below, and are summarized in the Corps BA in Appendix G, Table 42. The with-project conditions for the focus fish species and life stages were evaluated over a 50-year assessment timeline with baseline habitat values for each species and life stage described by pre-project conditions. Biological responses of each focus fish species life stage and average seasonal water surface elevation were predicted within each habitat unit and for each time step, based on habitat variable values and fish residency determined *West Sacramento Project SAM Analysis October 2014* from region-specific timing tables (USACE 2012b). This analysis automatically includes or excludes particular life stages of the focus fish by assessing the river mile locations of each bank repair site, with the encoded timing tables. In general, as calculated, positive differences between the existing and with-project responses are considered to result in improved growth and survival for the focus fish species (i.e., the bank repair action produced superior conditions than pre-project conditions). Negative values indicate the bank repair actions produced inferior conditions when compared with pre-project conditions and reduced growth and survival over a 30 day exposure period. In almost all cases, regardless of the integrated conservation and compensation measures (i.e., installation of IWM, planting riparian habitat, and construction of engineered floodplain) there is a short-term temporal negative habitat impact associated with many of the bank repair activities, mainly because new levee configurations move the river bank away from existing, protected riparian vegetation and because it takes several years for newly planted riparian vegetation to growth out over the river channel and create overhanging shade and other benefits to aquatic habitat such as a source of macroinvertebrate production.

Sacramento River

NMFS reviewed the SAM results provided by the Corps. Details of the SAM results can be found in Appendices E-G of the BA (Corps 2014) and in the main content of the BA. This includes tables and graphs of the SAM results from year 0 (beginning of construction) to year 50. Table 10 summarizes all negative West Sacramento Project SAM WRI values for Chinook salmon, steelhead, and green sturgeon. It is important to note that when interpreting SAM results, year 0 refers to the year of construction.

The impacts will occur along approximately 5.5 miles of the west bank of the Sacramento River and an revetment will cover at least 17 acres of small substrate benthic habit (assuming that an average revetment width of 25 feet below the fall water surface elevation. The main factors driving SAM deficits are the short-term reduction in riparian habitat and instream woody material, and the conversion of small substrate to rock revetment. For sturgeon, the most significant habitat change affecting SAM results is the conversion of small substrate to revetment. For salmon and steelhead, conditions improve over time after IWM is placed at the site and the end of construction, and as riparian habitat matures.

Summary of CV spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, CCV steelhead and sDPS green sturgeon effects by water surface elevation:

At fall water surface elevations:

Reduced growth and survival of fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead are expected for up to 10 years after any construction activities associated with the West Sacramento Project due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effects are greatest in year 6 for each species at -85 WRI, -85, and -122, respectively, and is reduced to -24, -24, and -11, respectively, by year 10. Following year 10, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival conditions are expected. By year 50, improved conditions for fry and juvenile and juvenile migration rearing reach 451 above baseline.

Reduced growth and survival of juvenile migrating (smolts) CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 15 years after any construction activities associated with the West Sacramento Project due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this adverse effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 7 for each species at -774 WRI, -774, and -777, respectively, and is reduced to -335, -335, and -441, respectively, by year 15. Between years 15 and 25, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival conditions are expected. By year 50, improved conditions for fry and juvenile and juvenile migration rearing reach 565 ft above baseline.

Shoreline habitat conditions for fry and juvenile rearing sDPS green sturgeon is expected to improve for the life of the project compared to baseline. The improved conditions begin at year 0 (immediately after construction) and increase to 1,521 WRI by year 50.

Shoreline habitat conditions from levee repairs could adversely affect the growth and survival of juvenile migrating green sturgeon for at least 50 years after any construction activities associated with the West Sacramento Project due to impacts associated with changes in back substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this adverse effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect starts at year 6 at -53 WRI and reaches -650 WRI and does not recover over the life of the project.

At winter water surface elevations:

Reduced survival of adult migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 for each species at -627 WRI, and -1,235, respectively, and is reduced to -72, -72, and -93, respectively, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions and improved survival is expected. After year two, survival will increase over baseline from 121 at year 3 to 430 feet at year 50.

Reduced growth and survival of fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 1 year after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 for each species at -183 WRI, -183, and -349, respectively, and is reduced to -2 for CCV steelhead by year 2. Following year 1 (and year 2 for CCV steelhead), the SAM modeled habitat conditions exceed baseline conditions improved growth and survival is expected. After year one, survival and growth values improve to 42 at year one for salmon and 416 by year two for steelhead, and reach 3,882 for salmon and 2,642 for steelhead by year 50.

Reduced growth and survival of juvenile migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 for each species at -2,392 WRI, -2,392, and -1,972, respectively, and is reduced to -272, -272, and -282, respectively, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival is expected. After year two, survival and growth values improve to 492 for salmon and 319 by year three for steelhead, and reach 3,882 for salmon and 2,646 for steelhead by year 50.

Reduced survival of adult resident CCV steelhead (kelts) is expected for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this adverse effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 at -1,235 WRI, and is reduced to -93, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions and improved survival is expected. After year two, survival and growth values improve to 302 for steelhead, and reach 1,578 for steelhead by year 50.

Shoreline habitat conditions from levee repairs could adversely affect the growth and survival of fry and juvenile rearing sDPS green sturgeon for at least 50 years after project construction due to impacts to riparian habitat, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The adverse effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect reaches -2,264 WRI at year 0 and does not recover over the life of the project. The SAM value is -317 at year 50.

At spring water surface elevations:

The SAM displays reduced survival of adult migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 3 years (2 years for CCV steelhead) after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this adverse effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 for each species at -773 WRI, -773, and -1,464, respectively, and is reduced to -67, -67, and -377, respectively, by year 3 (year 2 for CCV steelhead). These effects are considered to be insignificant because, although modeled as a result of a reduction in IWM and riparian habitat, the actual survival of adults is unlikely to be affected because there will be no increase in predation, and the upstream migration will not be impeded by any structural features that influence upstream migration. Following year 3 (year 2 for CCV steelhead), the SAM modeled habitat conditions exceed baseline conditions and improved survival is expected. Following year 2, the SAM modeled habitat conditions exceed baseline conditions and improved survival is expected. After year two, survival will increase over baseline from 74 at year 4 to 707 at year 50.

Reduced growth and survival of fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 1 year after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 for each species at -316 WRI, -316, and -550, respectively, and is reduced to -57, -57 and -213, respectively, by year 1. Following year 1, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival is expected. After year one, survival and growth values improve to 330 at year two for salmon and 335 for steelhead, and reach 2,228 for salmon and 2,813 for steelhead by year 50.

Reduced growth and survival of fry and juvenile migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 for each species at -2,639 WRI, -2,639, and -2,206, respectively, and is reduced to -312, -312, and -455, respectively, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival is expected. After year one, survival and growth values improve to 586 at year three for salmon and 225 for steelhead, and reach 4,104 for salmon and 2,841 for steelhead by year 50.

Reduced survival of adult resident CCV steelhead is expected for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 at -1,464 WRI, and is reduced to -377, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions improved survival is expected. Following year 2, the SAM modeled habitat conditions exceed baseline conditions improved survival. After year two, survival and growth values improve to 330 for steelhead, and reach 4,104 for steelhead by year 50.

Shoreline habitat conditions from levee repairs could adversely affect the growth and survival of fry and juvenile rearing sDPS green sturgeon for at least 50 years after project construction due to impacts to riparian habitat, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The effects are quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of the adverse effect is -2,264 WRI at year 0 and does not recover over the life of the project. The SAM value is -317 at year 50.

Shoreline habitat conditions from levee repairs could adversely affect the growth and survival of juvenile migrating sDPS green sturgeon for at least 50 years after project construction due to impacts to riparian habitat, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The effects are quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect reaches -650 WRI at year 50 and does not recover over the life of the project.

At summer water surface elevations:

Reduced survival of adult migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 for each species at -847 WRI, -847, and -1,644, respectively, and is reduced to -34, -34, and -18, respectively, by year 10, 11, 15. Following year 10, 10 and 6, the SAM modeled habitat conditions exceed baseline conditions and improved survival is expected. The maximum benefits are displayed in table 10.

Reduced growth and survival of fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 11 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 1 for each species at -168, WRI, -168, and -315, respectively, and is reduced to -24, -11, and -11 respectively, for each species. Following year 11 the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival is expected. After year one, survival and growth values improve to 445, 445 and 871.

Reduced growth and survival of juvenile migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 for each species at -2,392 WRI, -2,392, and -1,972, respectively, and is reduced to -272, -272, and -282, respectively, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival is expected. After year two, survival and growth values improve to 492 for salmon and 319 by year three for steelhead, and reach 3,882 for salmon and 2,646 for steelhead by year 50.

Reduced survival adult residence CCV steelhead is expected for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this adverse effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 at -1,235 WRI, and is reduced to -93, by year 2.

Following year 2, the SAM modeled habitat conditions exceed baseline conditions and improved survival is expected. After year two, survival and growth values improve to 302 for steelhead, and reach 1,578 for steelhead by year 50.

Shoreline habitat conditions from levee repairs could adversely affect the growth and survival of fry and juvenile rearing sDPS green sturgeon for at 3 years after project construction due to impacts to riparian habitat, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The effects are quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect reaches -1,544 WRI at year 0 and recovers by year 3.

Shoreline habitat conditions from levee repairs could adversely affect the growth and survival of juvenile migrating sDPS green sturgeon for at least 50 years after project construction due to impacts to riparian habitat, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The effects are quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect reaches -650 WRI at year 50 and does not recover over the life of the project.

Deep Water Ship Channel/Port

Although not a primary migration corridor, the DWSC/Port are utilized by all species for rearing and upstream migration. The West Sacramento Ship Locks, as currently operated under a “decommissioned status”, block upstream migration of all species. The DWSC/Port are accessible and provide utilized habitat for juvenile migration, and fry and juvenile rearing life stages for salmon, steelhead and sturgeon due to tidal action in the north Delta.

In the DWSC/Port SAM analysis reach, SAM modeled habitat deficits occur for Chinook salmon for all life stages and all seasons, for the life of the project. As previously mentioned, NMFS assumes the same values for steelhead and values twice as high for green sturgeon. SAM modeled values never recover over baseline (Table 11 and Table 43 of Appendix G in the BA). These deficits are expected to cause a reduction in the growth and survival of all species and life stages, during all seasons, for 50 years after project construction due to loss of vegetation and overhanging shade as well as the armoring of the shoreline with rock revetment. Table 11 summarizes the maximum deficits for Chinook salmon, steelhead and green sturgeon. NMFS assessment of adverse effects to all species is summarized in the following paragraphs:

Reduced survival of adult migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for at least 50 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The adverse effect is greatest at year 50 at -316 WRI during fall, -124 during winter, -272 during spring, and -316 during summer.

Reduced growth and survival of fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for at least 50 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The adverse effect is greatest at year 50 at -157 WRI during fall, -202 during winter, -299 during spring, and -157 during summer.

Reduced growth and survival of juvenile migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for at least 50 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The adverse effect is greatest at year 50 at -744 WRI during fall, -1,506 during winter, -1,709 during spring, and -744 during summer.

The SAM modelled fish response for green sturgeon shows slight improvements to fry and juvenile rearing at all seasonal water surface elevations and no change from baseline for juvenile migration and adult residence. This response is primarily due to the small footprint of in-channel levee repair actions in the DWSC/Port and that in-water repairs will reduce the bank substrate size compared to existing conditions.

The DWSC/Port are not natural aquatic features (they are anthropomorphic features) and currently are considered low quality for rearing, growth and migration, especially for salmon and steelhead. They are also not primary migration corridors for Chinook salmon, steelhead and green sturgeon, and considered to be low value for salmon and steelhead in their current form. Green sturgeon, however, may rear in freshwater and estuarine environments for 1 to four years and, although there are data gaps on how this species utilizes the Deep Water Ship Channel, it is likely that it is used for foraging and growth, and therefore important of the productivity of the species.

The Corps has proposed to offset the adverse effects in the Deep Water Ship Channel with onsite compensation at the Southport setback site and along other reaches of the Sacramento River within the West Sacramento River project, or through conservation credit purchases. These offsets are likely to improve growth and survival of Chinook salmon, steelhead at higher value habitats in the Delta and along their primary migration corridor of the Sacramento River.

Yolo Bypass

The proposed action in the Yolo Bypass includes the construction of levee cutoff walls. Typically these do not result in effects to aquatic or nearshore riparian habitat. However, the ETL element of the action does not include a VVR and the Corps SAM analysis concludes that some vegetation may be removed during cutoff wall construction. Although riparian vegetation is not a key feature that drives juvenile fish survival and production in the bypass, it does play a role in shading the toe drain and providing structural recruitment to the toe drain and is an important element of aquatic macroinvertebrate breeding habitat adjacent to water bodies. The Corps additional conservation measures state that any disturbance or removal of vegetation will be replaced outside of the ETL vegetation free zone. This replacement will minimize the effect related to cutoff wall construction.

Table 10: West Sacramento Project Maximum SAM Modeled WRI Deficits and Duration of Deficits by Species, Life-Stage, and Season

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Values
Spring-Run Chinook Salmon				
Fall	Adult Migration	No Deficit	NA	1,004
	Fry and Juvenile Rearing	-85	10	451
	Juvenile Migration	-774	15	565
Winter	Adult Migration	-627	2	430
	Fry and Juvenile Rearing	-183	1	1,440
	Juvenile Migration	-2,392	2	3,882
Spring	Adult Migration	-773	3	707
	Fry and Juvenile Rearing	-316	2	2,228
	Juvenile Migration	-2,692	3	4,104
Summer	Adult Migration	-847	10	963
	Fry and Juvenile Rearing	-168	11	445
	Juvenile Migration	-1,696	15	508
Winter-Run Chinook Salmon				
Fall	Adult Migration	No Deficit	NA	1,004
	Fry and Juvenile Rearing	-85	10	451
	Juvenile Migration	-774	15	565
Winter	Adult Migration	-627	3	430
	Fry and Juvenile Rearing	-183	1	1,440
	Juvenile Migration	-2,392	3	3,882
Spring	Adult Migration	-773	3	707
	Fry and Juvenile Rearing	-316	2	2,228
	Juvenile Migration	-2,639	3	4,104
Summer	Adult Migration	-847	10	963
	Fry and Juvenile Rearing	-168	11	445

Implementation of the Corps proposed Green Sturgeon Conservation Measures

The implementation of the Corp's Green Sturgeon Conservation Measures will serve several purposes to address scientific uncertainty about the species in the study area and to provide compensatory mitigation for the adverse effects related to shoreline and benthic habitat impacts. The HMMP with ensure that adverse impacts of future West Sacramento projects are sufficiently compensated in order to allow for the growth, survival and recovery of the species in the study area. Coordination of the HMMP with the IEP will leverage green sturgeon scientific expertise to ensure selected mitigation actions fully address the micro- and macro-ecological and survival needs of the species in the study area. Refinement of the SAM or development of alternative green sturgeon survival and response model using the Corps' Hydrologic Ecosystem Function Model, in consultation with NMFS and the IEP, will result in new modeling capacity that more accurately evaluates adverse project actions and the beneficial effects of mitigation actions relative to the growth and survival of green sturgeon in the study area. Restoring and compensating for the number of acres and ecological function of impacted benthic habitat and the initiation of this compensatory mitigation in the study area prior to the commencement of levee construction will reduce the impact of levee construction actions. The development of SMART compensatory mitigation objectives will ensure that all of the ecological impacts of levee construction actions are fully addressed.

CCV Steelhead				
Fall	Adult Migration	No Deficit	NA	2,309
	Fry and Juvenile Rearing	-122	10	883
	Juvenile Migration	-777	15	559
	Adult Residence	No Deficit	NA	2,309
Winter	Adult Migration	-1,235	3	1,578
	Fry and Juvenile Rearing	-349	2	1,980
	Juvenile Migration	-1,973	3	2,646
	Adult Residence	-1,235	3	1,578
Spring	Adult Migration	-1,464	3	1,923
	Fry and Juvenile Rearing	-550	1	2,813
	Juvenile Migration	-2,206	3	2,841
	Adult Residence	-1,464	3	1,923
Summer	Adult Migration	-1,644	6	2,227
	Fry and Juvenile Rearing	-315	11	871
Southern DPS Green Sturgeon				
Fall	Fry and Juvenile Rearing	No Deficit	NA	1,661
	Juvenile Migration	-650	50+ years	No Benefit
Winter	Adult Migration	NA	NA	NA
	Fry and Juvenile Rearing	-2,264	50+ years	No Benefit
	Adult Residence	-5,516	50+ years	No Benefit
Spring	Adult Migration	NA	NA	NA
	Fry and Juvenile Rearing	-2,264	50+ years	No Benefit
	Juvenile Migration	-650	50+ years	No Benefit
	Adult Residence	NA	NA	NA
Summer	Adult Migration	-650	50+ years	No Benefit
	Fry and Juvenile Rearing	-1,544	3	1,447
	Juvenile Migration	-650	50+ years	No Benefit
	Adult Residence	NA	NA	NA

Table 11: Deep Water Ship Channel / Port Maximum SAM modeled WRI Deficits and Duration of Deficits by Species, Life-Stage, and Season

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Values
Spring-Run Chinook Salmon				
Fall	Adult Migration	-316	50+ years	No Benefit
	Fry and Juvenile Rearing	-157	50+ years	No Benefit
	Juvenile Migration	-744	50+ years	No Benefit
Winter	Adult Migration	-124	50+ years	No Benefit
	Fry and Juvenile Rearing	-202	50+ years	No Benefit
	Juvenile Migration	-1506	50+ years	No Benefit
Spring	Adult Migration	-272	50+ years	No Benefit
	Fry and Juvenile Rearing	-299	50+ years	No Benefit
	Juvenile Migration	-1709	50+ years	No Benefit
Winter-run Chinook Salmon				
Fall	Adult Migration	-316	50+ years	No Benefit
	Fry and Juvenile Rearing	-157	50+ years	No Benefit
	Juvenile Migration	-744	50+ years	No Benefit
Winter	Adult Migration	-124	50+ years	No Benefit
	Fry and Juvenile Rearing	-202	50+ years	No Benefit
	Juvenile Migration	-1506	50+ years	No Benefit
Spring	Adult Migration	-272	50+ years	No Benefit
	Fry and Juvenile Rearing	-299	50+ years	No Benefit
	Juvenile Migration	-1709	50+ years	No Benefit
CV Steelhead				
Summer	Adult Migration	-505	50+ years	No Benefit
	Fry and Juvenile Rearing	-327	50+ years	No Benefit
	Juvenile Migration	-798	50+ years	No Benefit
	Adult Residence	-505	50+ years	No Benefit

Fall	Adult Migration	-504	50+ years	No Benefit
	Fry and Juvenile Rearing	-327	50+ years	No Benefit
	Juvenile Migration	-798	50+ years	No Benefit
	Adult Residence	-505	50+ years	No Benefit
Winter	Adult Migration	-232	50+ years	No Benefit
	Fry and Juvenile Rearing	-408	50+ years	No Benefit
	Juvenile Migration	-1328	50+ years	No Benefit
	Adult Residence	-232	50+ years	No Benefit
Spring	Adult Migration	-452	50+ years	No Benefit
	Fry and Juvenile Rearing	-574	50+ years	No Benefit
	Fry and Juvenile Rearing	-1544	50+ years	No Benefit
	Adult Residence	-452	50+ years	No Benefit
Green Sturgeon				
Fall	Adult Migration	NA	NA	NA
	Fry and Juvenile Rearing	No Deficit	NA	108
	Fry and Juvenile Rearing	No Deficit	No Deficit	No Benefit
	Adult Residence	No Deficit	No Deficit	No Benefit
Winter	Adult Migration	NA	NA	NA
	Fry and Juvenile Rearing	No Deficit	No Deficit	108
	Fry and Juvenile Rearing	No Deficit	No Deficit	No Benefit
	Adult Residence	No Deficit	No Deficit	No Benefit
Spring	NA	NA	NA	NA
	Fry and Juvenile Rearing	No Deficit	No Deficit	108
	Fry and Juvenile Rearing	No Deficit	No Deficit	No Benefit
	Adult Residence	NA	NA	NA
Summer	Adult Migration	NA	NA	NA
	Fry and Juvenile Rearing	No Deficit	No Deficit	108
	Fry and Juvenile Rearing	No Deficit	No Deficit	No Benefit
	Adult Residence	NA	NA	NA

2.4.4 Project Effects on Critical Habitat

For CV spring-run Chinook salmon and steelhead, the project generally will have short term impacts on the freshwater rearing and freshwater rearing PCEs of critical habitat. For winter-run Chinook salmon, and for winter-run Chinook salmon impacted essential features of critical habitat that will be affect include the river water, river bottom, and adjacent riparian zone used by fry and juveniles for rearing. The SAM model, which models fish response, also serves as a good proxy for measuring impact to these species critical habitat because it the model evaluates changes to important attributes of PCEs and essential features including overhanging shade, substrate size, instream woody material, bank slope and instream aquatic vegetation. The changes to these features are recognized in Table 10 above. In general, impacts to critical habitat will generally last between 1 and 10 years, and in almost all cases they improve each year and eventually exceed baseline conditions over the life of the project. For these reasons, we do not expect the proposed action to reduce the conservation value of the critical habitat.

Because the proposed action occurs along the lower Sacramento River at the convergence of the north Delta, the action area includes both freshwater and estuarine habitat types. For green sturgeon, this means there are freshwater and estuarine including:

Freshwater

a) Food resources. Abundant prey items for larval, juvenile, subadult, and adult life stages.
b) Substrate type or size (*i.e.*, structural features of substrates). Substrates suitable for egg deposition and development (*e.g.*, bedrock sills and shelves, cobble and gravel, or hard clean sand, with interstices or irregular surfaces to "collect" eggs and provide protection from predators, and free of excessive silt and debris that could smother eggs during incubation), larval development (*e.g.*, substrates with interstices or voids providing refuge from predators and from high flow conditions), and feeding of juveniles, subadults, and adults (*e.g.*, sand/mud substrates).

Estuarine

a) Food resources. Abundant prey items within estuarine habitats and substrates for juvenile, subadult, and adult life stages.

The Corps estimates that approximately 19 acres of soft substrate habitat below the ordinary high water mark will be permanently lost to rock revetment. This is a conceptual estimate that will be further refined during the preliminary engineering design (PED) phase before construction begins. This loss of habitat is expected to adversely affect benthic substrate and impair food resources for all life stages; and the quantity of sediment to allow for normal physiological and behavioral responses to the environment. Similar to salmon and steelhead, the SAM serves as a reasonable proxy for measuring impacts to critical habitat. For most life stages and season water surface elevations, the SAM show immediate adverse effects that continue to decline for the life of the project. However, the Corps' Green Sturgeon Conservation Measures will reduce the impact on critical habitat by providing compensatory mitigation within the action area.

Specifically, the HMMP shall also restore or compensate for the number of acres and ecological function of soft bottom benthic substrate for sDPS green sturgeon permanently lost to project construction. This compensation will be carried out within the lower Sacramento River/North Delta in order to offset the adverse modification to designated critical habitat. The restored habitat will be capable of providing abundant benthic prey, freshwater or estuarine areas with adequate water quality, temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth and viability of all life stages. It will also provide safe and unobstructed migratory pathways necessary for timely passage of adult, sub-adult, and juvenile fish within the region's different estuarine habitats and between the upstream riverine habitat and the marine habitats.

2.5 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

2.5.1 Water Diversions and Agricultural Practices

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found along the West Sacramento GRS action area. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill many life stages of aquatic species, including juvenile listed anadromous species. For example, as of 1997, 98.5 percent of the 3,356 diversions included in a CV database were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001).

Agricultural practices in the action area may adversely affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow. Grazing activities from cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into the receiving waters of the associated watersheds. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may adversely affect listed salmonid and sDPS green sturgeon reproductive success and survival rates (Dubrovsky *et al.* 1998, 2000; Daughton 2003).

2.5.2 Aquaculture and Fish Hatcheries

More than 32-million fall-run Chinook salmon, 2-million spring-run Chinook salmon, 1-million late fall-run Chinook salmon, 0.25-million winter-run Chinook salmon, and 2-million steelhead are released annually from six hatcheries producing anadromous salmonids in the CV. All of these facilities are currently operated to mitigate for natural habits that have already been permanently lost as a result of dam construction. The loss of this available habitat results in dramatic reductions in natural population abundance which is mitigated for through the operation of hatcheries. Salmonid hatcheries can, however, have additional negative effects on ESA-listed salmonid populations. The high level of hatchery production in the CV can result in high harvest-to-escapements ratios for natural stocks. California salmon fishing regulations are set according to the combined abundance of hatchery and natural stocks, which can lead to over-exploitation and reduction in the abundance of wild populations that are indistinguishable and exist in the same system as hatchery populations. Releasing large numbers of hatchery fish can also pose a threat to wild Chinook salmon and steelhead stocks through the spread of disease, genetic impacts, competition for food and other resources between hatchery and wild fish, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production. Impacts of hatchery fish can occur in both freshwater and the marine ecosystems. Limited marine carrying capacity has implications for naturally produced fish experiencing competition with hatchery production. Increased salmonid abundance in the marine environment may also decrease growth and size at maturity, and reduce fecundity, egg size, age at maturity, and survival (Bigler *et al.* 1996). Ocean events cannot be predicted with a high degree of certainty at this time. Until good predictive models are developed, there will be years when hatchery production may be in excess of the marine carrying capacity, placing depressed natural fish at a disadvantage by directly inhibiting their opportunity to recover (NPCC 2003).

2.5.3 Increased Urbanization

Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. Increased growth will place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions, particularly those which are situated away from waterbodies, will not require Federal permits, and thus will not undergo review through the ESA section 7 consultation process with NMFS.

Increased urbanization also is expected to result in increased recreational activities in the region. Among the activities expected to increase in volume and frequency is recreational boating. Boating activities typically result in increased wave action and propeller wash in waterways. This potentially will degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments thereby potentially re-suspending contaminated sediments and degrading areas of submerged vegetation. This in turn will reduce habitat quality for the invertebrate forage base required for the survival of juvenile salmonids and green sturgeon moving through the system. Increased recreational boat operation is anticipated to result in more contamination from the operation of gasoline and diesel powered engines on watercraft entering the associated water bodies.

2.5.4 Global Climate Change

The world is about 1.3°F warmer today than a century ago and the latest computer models predict that, without drastic cutbacks in emissions of carbon dioxide and other gases released by the burning of fossil fuels, the average global surface temperature may rise by two or more degrees in the 21st century (IPCC 2001). Much of that increase likely will occur in the oceans, and evidence suggests that the most dramatic changes in ocean temperature are now occurring in the Pacific (Noakes 1998). Using objectively analyzed data Huang and Liu (2000) estimated a warming of about 0.9°F per century in the Northern Pacific Ocean.

Sea levels are expected to rise by 0.5 to 1.0 meters in the northeastern Pacific coasts in the next century, mainly due to warmer ocean temperatures, which lead to thermal expansion much the same way that hot air expands. This will cause increased sedimentation, erosion, coastal flooding, and permanent inundation of low-lying natural ecosystems (*e.g.*, salt marsh, riverine, mud flats) affecting listed salmonid and green sturgeon PCEs. Increased winter precipitation, decreased snow pack, permafrost degradation, and glacier retreat due to warmer temperatures will cause landslides in unstable mountainous regions, and destroy fish and wildlife habitat, including salmon-spawning streams. Glacier reduction could affect the flow and temperature of rivers and streams that depend on glacier water, with negative impacts on fish populations and the habitat that supports them.

Summer droughts along the South Coast and in the interior of the northwest Pacific coastlines will mean decreased stream flow in those areas, decreasing salmonid survival and reducing water supplies in the dry summer season when irrigation and domestic water use are greatest. Global warming may also change the chemical composition of the water that fish inhabit: the amount of oxygen in the water may decline, while pollution, acidity, and salinity levels may increase. This will allow for more invasive species to overtake native fish species and impact predator-prey relationships (Peterson and Kitchell 2001, Stachowicz *et al.* 2002).

In light of the predicted impacts of global warming, the CV has been modeled to have an increase of between +2ºC and +7ºC by 2100 (Dettinger *et al.* 2004, Hayhoe *et al.* 2004, Van Rheenen *et al.* 2004, Stewart 2005), with a drier hydrology predominated by rainfall rather than snowfall. This will alter river runoff patterns and transform the tributaries that feed the CV from a spring and summer snowmelt dominated system to a winter rain dominated system. It can be hypothesized that summer temperatures and flow levels will become unsuitable for salmonid survival. The cold snowmelt that furnishes the late spring and early summer runoff will be replaced by warmer precipitation runoff. This will truncate the period of time that suitable cold-water conditions exist downstream of existing reservoirs and dams due to the warmer inflow temperatures to the reservoir from rain runoff. Without the necessary cold water pool developed from melting snow pack filling reservoirs in the spring and early summer, late summer and fall temperatures downstream of reservoirs, such as Lake Shasta, could potentially rise above thermal tolerances for juvenile and adult salmonids (*i.e.* Sacramento River winter-run Chinook salmon and CCV steelhead) that must hold and/or rear downstream of the dam over the summer and fall periods.

2.5.5 Rock Revetment and Levee Repair Projects

Cumulative effects include non-Federal riprap projects. Depending on the scope of the action, some non-Federal riprap projects carried out by state or local agencies do not require Federal permits. These types of actions and illegal placement of riprap occur within the Sacramento River watershed. For example, most of the levees have roads on top of the levees which are either maintained by the county, reclamation district, owner, or by the state. Landowners may utilize roads at the top of the levees to access part of their agricultural land. The effects of such actions result in continued fragmentation of existing high-quality habitat, and conversion of complex nearshore aquatic to simplified habitats that affect salmonids in ways similar to the adverse effects associated with the West Sacramento Project.

2.6 Integration and Synthesis

The *Integration and Synthesis* section is the final step of NMFS' assessment of the risk posed to species and critical habitat as a result of the proposed action. In this section, NMFS performs two evaluations: whether, given the environmental baseline and status of the species and critical habitat, as well as future cumulative effects, it is reasonable to expect the proposed action is not likely to: (1) reduce the likelihood of both survival and recovery of the species in the wild; and (2) result in the destruction or adverse modification of designated critical habitat (as determined by whether the critical habitat will remain functional to serve the intended conservation role for the listed anadromous species or retain its current ability to establish those features and functions essential to the conservation of the species).

The *Analytical Approach* described the analyses and tools we have used to complete this analysis. This section is based on analyses provided in the *Status of the Species*, the *Environmental Baseline*, and the *Effects of the Proposed Action*.

In our *Status of the Species* section, NMFS summarized the current likelihood of extinction of each of the listed species. We described the factors that have led to the current listing of each species under the ESA across their ranges. These factors include past and present human activities and climatological trends and ocean conditions that have been identified as influential to the survival and recovery of the listed species. Beyond the continuation of the human activities affecting the species, we also expect that ocean condition cycles and climatic shifts will continue to have both positive and negative effects on the species' ability to survive and recover. The *Environmental Baseline* reviewed the status of the species and the factors that are affecting their survival and recovery in the action area. The *Effects of the Proposed Action* reviewed the exposure of the species and critical habitat to the proposed action and interrelated and interdependent actions, cumulative effects. NMFS then evaluated the likely responses of individuals, populations, and critical habitat. The *Integration and Synthesis* will consider all of these factors to determine the proposed action's influence on the likelihood of both the survival and recovery of the species, and on the conservation value of designated critical habitat.

The criteria recommended for low risk of extinction for Pacific salmonids are intended to represent a species and populations that are able to respond to environmental changes and withstand adverse environmental conditions. Thus, when our assessments indicate that a species or population has a moderate or high likelihood of extinction, we also understand that future adverse environmental changes could have significant consequences on the ability of the species to survive and recover. Also, it is important to note that an assessment of a species having a moderate or high likelihood of extinction does not mean that the species has little or no chance to survive and recover, but that the species faces moderate to high risks from various processes that can drive a species to extinction. With this understanding of both the current likelihood of extinction of the species and the potential future consequences for species survival and recovery, NMFS will analyze whether the effects of the proposed action are likely to in some way increase the extinction risk each of the species faces.

In order to estimate the risk to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and green sturgeon as a result of the proposed action, NMFS uses a hierarchical approach. The condition of the ESU or DPS is reiterated from the *Status of the Species* section of this BiOp. We then consider how the status of populations in the action area, as described in the *Environmental Baseline*, is affected by the proposed action. Effects to individuals is summarized, and to the consequence of those effects is applied to establish risk to the diversity group, ESU, or DPS.

In designating critical habitat, NMFS considers the physical and biological features (essential features) within the designated areas that are essential to the conservation of the species and that may require special management considerations or protection. Such requirements of the species include, but are not limited to: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing offspring, and generally; and (5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of this species [see 50 CFR § 424.12(b)]. In addition to these factors, NMFS also focuses on the principal biological or physical constituent elements within the defined area that are essential to the conservation of the species. Primary constituent elements may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation.

The basis of the "destruction or adverse modification" analysis is to evaluate whether the proposed action results in negative changes in the function and role of the critical habitat in the conservation of the species. As a result, NMFS bases the critical habitat analysis on the affected areas and functions of critical habitat essential to the conservation of the species, and not on how individuals of the species will respond to changes in habitat quantity and quality.

2.6.2 Status of the Sacramento River Winter-run Chinook Salmon ESU

There are several criteria (only one is required) that would qualify the winter-run ESU at moderate risk of extinction, and since there is still only one population that spawns downstream of Keswick Dam, that population would be at high risk of extinction in the long-term according the criteria in Lindley *et al.* (2007). Recent trends in those criteria are: (1) continued low abundance (Figure 3) ; (2) a negative growth rate over 6 years (2006–2012), which is two complete generations (Figure 4); (3) a significant rate of decline since 2006; and (4) increased risk of catastrophe from oil spills, wild fires, or extended drought (climate change). The most recent 5-year status review (NMFS 2011) on winter-run concluded that the ESU had increased to a high risk of extinction. In summary, the most recent biological information suggests that the extinction risk for the winter-run ESU has increased from moderate risk to high risk of extinction since 2005 (last review), and that several listing factors have contributed to the recent decline, including drought and poor ocean conditions (NMFS 2011).

2.6.3 Status of the CV Spring-run Chinook Salmon ESU

The CV spring-run Chinook salmon ESU is at moderate risk of extinction (Lindley *et al.* 2007). The most recent viability assessment of CV spring-run Chinook salmon was conducted during NMFS' 2011 status review (NMFS 2011b). This review found that the biological status of the ESU has worsened since the last status review. In the 2011, the ESU as a whole could not be considered viable because there were no extant viable populations in the three other diversity groups. In addition, Mill, Deer, and Butte creeks are close together geographically, decreasing the independence of their extinction risks due to catastrophic disturbance. These and other conditions covered in the 2011 status review have not changed since 2011. While the abundance for some populations appears to be slightly improving, the ESU is still demonstrating a high variability in adult abundance (especially in Butte Creek), we cannot say based on the trend over the past three years that the risk of extinction for the ESU has improved.

2.6.4 Summary of the Status of the CCV Steelhead DPS

All indications are that natural Central Valley steelhead have continued to decrease in abundance and in the proportion of natural fish over the past 25 years (Good et al. 2005; NMFS 2011); the long-term trend remains negative. Hatchery production and returns are dominant over natural fish, and one of the four hatcheries is dominated by Eel/Mad River origin steelhead stock. Continued decline in the ratio between naturally produced juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts indicates that the wild population abundance is declining. Hatchery releases (100 percent adipose fin-clipped fish since 1998) have remained relatively constant over the past decade, yet the proportion of adipose fin-clipped hatchery smolts to unclipped naturally produced smolts has steadily increased over the past several years.

Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin Basin continue to show an overall very low abundance, and fluctuating return rates. Lindley et al. (2007) developed viability criteria for Central Valley salmonids. Using data through 2005, Lindley et al. (2007) found that data were insufficient to determine the status of any of the naturally-spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, which were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas.

The widespread distribution of wild steelhead in the Central Valley provides the spatial structure necessary for the DPS to survive and avoid localized catastrophes. However, most wild CCV populations are very small, are not monitored, and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change (NMFS 2011). The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to wild fish. The life-history diversity of the DPS is mostly unknown, as very few studies have been published on traits such as age structure, size at age, or growth rates in CCV steelhead.

The CCV steelhead DPS is at high risk of extinction (NMFS 2011c), and the extinction risk is increasing. The most recent viability assessment of CCV steelhead was conducted during NMFS' 2011 status review (NMFS 2011c). This review found that the biological status of the ESU has worsened since the last status review recommend that its status be reassessed in two to three years as opposed to waiting another five years, if it does not respond positively to improvements in environmental conditions and management actions.

2.6.5 Summary of the Status of the Green Sturgeon southern DPS

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate because, although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS 2010a).

Although the population structure of sDPS green sturgeon is still being refined, it is currently believed that only one population of sDPS green sturgeon exists. Lindley et al. (2007), in discussing winter-run Chinook salmon, states that an ESU represented by a single population at moderate risk of extinction is at high risk of extinction over the long run. This concern applies to any DPS or ESU represented by a single population, and if this were to be applied to sDPS green sturgeon directly, it could be said that sDPS green sturgeon face a high extinction risk. However, the position of NMFS, upon weighing all available information (and lack of information) has stated the extinction risk to be moderate (NMFS 2010a).

Adult green sturgeon migrate through the action area to reach upstream spawning habitat. Early larval drift and rearing is also likely to occur upstream from the action area near spawning sites. As juveniles migrate downstream toward the ocean, they become more oriented to benthic environments. Juvenile green sturgeon migrate toward seawater portions of natal estuaries as early as one and a half years old (75cm TL, Allen and Cech 2007). Juvenile and subadult green sturgeon may rear in freshwater and brackish water for up to three years. During laboratory experiments, juvenile green sturgeon select low light habitats and are primarily inactive during daylight hours, while they seemed to forage actively during night (Kynard et al. 2005). Juvenile green sturgeon were captured during the summer in shallow shoals (1-3 m deep) in the lower San Joaquin River (Radtke 1966), and are assumed to occupy similar habitats along the lower Sacramento River.

There is a strong need for additional information about sDPS green sturgeon, especially with regards to a robust abundance estimate, a greater understanding of their biology, and further information about their micro- and macro-habitat ecology.

2.6.6 Summary of Status of the Environmental Baseline and Cumulative Effects in the Action Area

The action area is used by most diversity groups and populations of the salmon, steelhead and green sturgeon ESUs and DPSs that are the subject of this BO. Salmon, steelhead and green sturgeon use the action area as an upstream and downstream migration corridor and for rearing.

Within the action area, the essential features of freshwater rearing and migration habitats for salmon, steelhead and green sturgeon have been transformed from a meandering waterway lined with a dense riparian vegetation, to a highly leveed system under varying degrees of constraint of riverine erosional processes and flooding. Levees have been constructed near the edge of the river and most floodplains have been completely separated and isolated from the Sacramento River (USFWS 2000). Severe long-term riparian vegetation losses have occurred in this part of the Sacramento River, and there are large open gaps without the presence of these essential features due to the high amount of riprap (USFWS 2000). The change in the ecosystem as a result of halting the lateral migration of the river channel, the loss of floodplains, the removal of riparian vegetation and IWM have likely affected the functional ecological processes that are essential for growth and survival of salmon, steelhead and green sturgeon in the action area.

The Southport EIP is a levee setback project that was consulted on in 2015 and will go to construction in 2016. The project will breach the existing levee at several sites and will result in the inundation of approximately 120 acres of historic floodplain habitat. Construction of the project will result in some short-term adverse effects to salmon, steelhead and green sturgeon, but after approximately 5 years post Southport construction, and prior to the construction of West Sacramento GRS actions, the WRI values will improve the existing (2015) baseline of the actions area for Chinook salmon and steelhead. Specifically, in the case of fry and juvenile rearing and migration for all species, the SAM modeled WRI values show increases in the growth and survival of individuals, such that the incremental effects of the Southport EIP are not expected to increase the extinction risk of the Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon and ESU CCV steelhead and green sturgeon DPS or reduce the conservation value of their designated critical habitat.

Furthermore, the anticipated growth and survival of salmon, steelhead and green sturgeon rearing and juvenile migration are positive and demonstrate how integrating NMFS high priority recovery actions, such as setback levee construction and restoration of floodplain habitat can contribute to an increase in the production and abundance of the Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon and ESU CCV steelhead and green sturgeon DPS.

The *Cumulative Effects* section of this BO describes how continuing or future effects such as non-Federal water diversions, the discharge of point and non-point source chemical contaminant discharges, and climate change affect the species in the action area. These actions typically result in habitat fragmentation, and conversion of complex nearshore aquatic habitat to simplified habitat conditions that reduce the carrying capacity of the rearing and migratory corridors.

2.6.7 Summary of Project Effects on Sacramento River Winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and sDPS Green Sturgeon Individuals

1. <u>Construction and O&M-related Effects</u>

During construction and O&M, some injury or death to individual fish could result from rock placement (crushing), or predation related to displacement of individuals away from the shoreline or at the margins or turbidity plumes. These construction type actions will occur during summer and early fall months, when the abundance of individual salmon and steelhead is low and should result in correspondingly low levels of injury or death.

Green sturgeon adults may be migrating downstream through the area during construction (Heublein et al. 2009) and juveniles may be in the area May through September (noted in section 2.4.1, pg. 83). Adults and subadults would likely respond to construction activities by quickly swimming away, escaping injury, but juveniles are not strong swimmers and will experience the greatest exposure and may encounter short-term construction-related noise, physical disturbance, and water quality changes that may cause injury or harm by increasing the susceptibility of some individuals to predation by temporarily disrupting normal behaviors and affecting sheltering abilities.

2. Long-term Effects Related to the Presence of Project Features

For juvenile and outmigrating salmon and steelhead, the proposed action will result in short- and long-term adverse effects to individual salmon and steelhead that are exposed to the project features along the Sacramento River. These adverse effects are indexed by SAM model results and expressed as WRI deficits. The long term WRI deficits are highest at fall and summer water surface elevations. We interpret those flow conditions to be consistent with summer and fall months, which are seasons during which individual Sacramento River winter-run, CV spring-run and CCV steelhead is low (fall), or they are absent. For other seasonal water surface elevations, there will be short term reductions in survival and growth as indicated by WRI values, but these values will increase above baseline and result in beneficial conditions that exceed baseline values.

SAM modeled WRI values for adult salmon and steelhead migration and steelhead residence (outmigrating post spawning adults) are deficits at winter, spring and summer water surface elevations. These effects are considered to be *de minimus* because, although modeled as a result of a reduction in IWM and riparian habitat, the actual survival of adults is unlikely to be affected because there will be no increase in predation, and the upstream migration will not be impeded by any structural features that influence upstream migration.

Details regarding the extent of juvenile green sturgeon rear in this reach of the river is not clear, but all juvenile sDPS must pass through the area on their migration to the estuary and ocean (unless they wash into the Yolo Bypass during a flood event). Levee repair actions in the West Sacramento Study Area are likely to only affect the juvenile rearing life stage and probably have little to no adverse impacts on the adult life stages of green sturgeon because spawning habitat is not present in the action area and upstream migrating adults are probably more influenced by impacts that affect swimming speed and upstream passage than shoreline habitat manipulations. The levee repair actions will cause long-term reductions in shoreline habitat features for juvenile rearing and migrating green sturgeon and a loss of several acres of benthic habitat that is most likely used for foraging.

The implementation of the Corp's Green Sturgeon Conservation Measures will serve several purposes to address scientific uncertainty about the species in the study area and to provide compensatory mitigation for the adverse effects related to shoreline and benthic habitat impacts. The HMMP with ensure that adverse impacts of future West Sacramento projects are sufficiently compensated in order to allow for the growth, survival and recovery of the species in the study area. Coordination of the HMMP with the IEP will leverage green sturgeon scientific expertise to ensure selected mitigation actions fully address the micro- and macro-ecological and survival needs of the species in the study area. Refinement of the SAM or development of alternative green sturgeon survival and response model using the Corps' Hydrologic Ecosystem Function Model, in consultation with NMFS and the IEP, will result in new modeling capacity that more accurately evaluates adverse project actions and the beneficial effects of mitigation actions relative to the growth and survival of green sturgeon in the study area. Restoring and compensating for the number of acres and ecological function of impacted benthic habitat and the initiation of this compensatory mitigation in the study area prior to the commencement of levee construction will reduce the impact of levee construction actions. The development of SMART compensatory mitigation objectives will ensure that all of the ecological impacts of levee construction actions are fully addressed.

The SAM modeled deficits for the Sacramento River Deep Water Ship Channel and the Port of Sacramento are negative and correspond to reduced growth and survival of all life stages of salmon, steelhead for the entire life of the project (50 years). The channel and the port are not along the primary migration corridor and are generally not considered to be high value rearing or migratory habitats for salmon and steelhead. However the Corps has proposed to offset the negative WRI values through habitat enhancements or through the purchase of a NMFS approved conservation bank at sites that are of a higher conservation value for the species. Offsetting these deficits at high value areas will mean that the reduced growth and survival of the species in the Deep Water Ship Channel and the Port of Sacramento will not contribute to a reduction in the production and abundance of the winter-run Chinook salmon ESU or the CV spring-run Chinook salmon and CCV steelhead DPSs. It is uncertain what the deficits will mean to sDPS green sturgeon due to uncertainty of the value of this habitat to the species.

2.6.8 Summary of Project Effects on Sacramento River Winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and sDPS Green Sturgeon Critical Habitat

Within the action area, the relevant PCEs of the designated critical habitat for listed salmonids are migratory corridors and rearing habitat, and for green sturgeon the six PCEs include food resources, water flow, water quality, migratory corridors, water depth, and sediment quality.

Based on SAM modeled WRIs, we expect small reductions in the value of PCEs for salmon and steelhead freshwater rearing due to the temporary loss of riparian habitat, the conversion of natural substrate river banks with revetment and the short term loss of IWM, but these reductions are at fall and summer water surface elevations and not at water surface elevations when the habitat use is the highest and most significant. Additionally, as planted vegetation begins to grow, the quality of rearing habitat will improve over baseline. There will also be SAM modeled WRI deficits for adult migration-related PCEs for all species. These deficits are temporary and eventually increase over baseline, so over time we do not expect these effects to reduce the conservation value of critical habitat.

The current condition of critical habitat for the green sturgeon sDPS in the action area is degraded over its historical conditions. It does not provide the full extent of conservation values necessary for the survival and recovery of the species. In particular, passage and water flow

PCEs have been impacted by human actions, substantially altering the historical river characteristics in which the green sturgeon sDPS evolved.

The Corps estimates that approximately 19 acres of soft substrate habitat below the ordinary high water mark will be permanently lost to rock revetment. This is a conceptual estimate that will be further refined during the PED phase before construction begins. This loss of habitat is expected to adversely affect benthic substrate and impair food resources for all life stages; and the quantity of sediment to allow for normal physiological and behavioral responses to the environment. Similar to salmon and steelhead, the SAM serves as a reasonable proxy for measuring impacts to critical habitat. For most life stages and season water surface elevations, the SAM show immediate adverse effects that continue to decline for the life of the project. However, the Corps' Green Sturgeon Conservation Measures will reduce the impact on critical habitat by providing compensatory mitigation within the action area. Specifically, the HMMP shall also restore or compensate for the number of acres and ecological function of soft bottom benthic substrate for sDPS green sturgeon permanently lost to project construction. This compensation will be carried out within the lower Sacramento River/North Delta in order to offset the adverse modification to designated critical habitat. The restored habitat will be capable of providing abundant benthic prey, freshwater or estuarine areas with adequate water quality, temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth and viability of all life stages. It will also provide safe and unobstructed migratory pathways necessary for timely passage of adult, sub-adult, and juvenile fish within the region's different estuarine habitats and between the upstream riverine habitat and the marine habitats.

The proposed action will permanently destroy up to 19 acres of critical habitat but also includes implementation of a comprehensive suite of conservation measures that will fill important data gaps, address existing modeling insufficiencies and implement compensatory measures with the goal of maintaining green sturgeon growth, survival and recovery in the action area through measures that will be developed in coordination with the IEP's green sturgeon project work team and in consultation with NMFS. The measures will be undertaken prior to or concurrent with project implementation. For these reasons, we expect the proposed action will not reduce the conservation value of critical habitat for sDPS green sturgeon.

2.6.9 Summary

Although there are some short-term and SAM modeled WRI deficits for salmon and steelhead, the effects of these deficits, when added to the environmental baseline and cumulative effects in the action area are small, occur during seasons when fish abundance is low or they are not present at all, and is of short duration. In the case of fry and juvenile rearing and migration for all species, the SAM modeled WRI values show significant increases in the growth and survival of individuals over baseline conditions between years 0 and 13, especially at winter spring water surface elevations, which represent a shoreline area where most emigrating salmon and steelhead would be exposed. Because the WRI measure growth and survival values recover rather quickly and generally exceed baseline conditions, the incremental effects of the action are not expected to increase the extinction risk of the Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon and ESU CCV steelhead and or reduce the conservation value of their designated critical habitat.

Furthermore, the anticipated growth and survival of salmon, steelhead rearing and juvenile migration are substantially positive and demonstrate how integrating NMFS high priority recovery actions, such as riparian habitat enhancement, engineered floodplain features (benches), integrated instream woody material contribute to an increase in the production and abundance of the Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon and ESU CCV steelhead.

The project will result in unavoidable impacts to the shoreline and benthic habitat of green sturgeon. However, the Corps' proposed Green Sturgeon Conservation Measures are expected to make significant contributions to monitor the species, address important data gaps in the action area, improve species growth and survival modeling and use the modeling to develop and track the performance of compensatory mitigation with the goal of fully addressing the loss of micro and macro-ecological impacts of the levee construction work in a manner that maintains the growth, survival and recovery of the species. The measures also address critical habitat PCEs and will ensure the conservation value of critical habitat is not reduced.

2.7 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and sDPS green sturgeon or destroy or adversely modify their designated critical habitat.

2.8 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

The measures described below are non-discretionary, and must be undertaken by the Corps so that they become binding conditions of any grant, contract or permit, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps: (1) fails to assume and implement the terms and conditions, or (2) fails to require the permittee, contractor, or grantee to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit, contract or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to NMFS as specified in the incidental take statement (50 CFR §402.14(i)(3)).

2.8.1 Amount or Extent of Take

NMFS anticipates incidental take of adult and juvenile listed CV spring-run Chinook salmon, CCV steelhead, and juvenile sDPS of North American green sturgeon and juvenile Sacramento River winter-run Chinook salmon in the action area through the implementation of the proposed action.

NMFS cannot, using the best available information, quantify the anticipated incidental take of individual Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the sDPS of North American green sturgeon because of the variability and uncertainty associated with the population size of each species, annual variations in the timing of migration, and uncertainties regarding individual habitat use of the project area. However, it is possible to describe the general programmatic conditions and ecological surrogates using negative SAM WRI values.

Accordingly, NMFS is quantifying take of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the sDPS of North American green sturgeon incidental to the action resulting from short-term construction impacts, as well as long-term impacts as indexed by the SAM model.

The amount and extent of take described below is in the form of harm due to habitat impacts that will reduce the growth and survival of individuals from predation, or by causing fish to relocate and rear in other locations and reduce the carrying capacity of the existing habitat. This SAM values represent the extent of habitat impacts that will harm fish. As described in the *Analytical Approach* and the *Effects Analysis Sections* of this BO, the SAM values represent an index of fish response to habitat variables to which fish respond including bank slope, bank substrate size, instream structure, overhanging shade, aquatic vegetation and floodplain availability. Positive SAM values represent a positive growth and survival response and negative values index negative growth and survival. There is not a stronger ecological surrogate based on the information available. Due to a lack of site-specific fish data, the exact number of fish that will be affected is not known. The following level of incidental take from program activities is anticipated:

Incidental Take Associated with Construction:

1. Take of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS of North American green sturgeon in the form of injury and death from predation caused by construction-related turbidity that extends up to 100 feet from the shoreline, and 1,000 feet downstream, along all project reaches for levee construction activities.

2. Take of juvenile and smolt Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the sDPS of North American green sturgeon, in the form of harm or injury of fish from O&M actions is expected from habitat-related disturbances from the annual placement of up to 600 cubic yards of material per site for the extent of the project life (*i.e.,* 50 years). Approximately 60 percent of the 600 cubic yards will be at or below the ordinary high water mark, or approximately 360 cubic yards. Take will be in the form of harm to the species through modification or degradation of the PCEs for rearing and migration that reduces the carrying capacity of habitat.

Incidental Take Associated with Exposure to Project Facilities along the Sacramento River

At fall water surface elevations:

1. Take in the form of harm to fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead for up to 10 years after any construction activities associated with the West Sacramento Project due to impacts to riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is greatest in year 6 for each species at -85 WRI, -85, and -12, respectively, and is reduced to -24, -24, and -11, respectively, by year 10. Following year 10, the SAM modeled habitat conditions exceed baseline conditions and harm from habitat modification is not expected.

2. Take in the form of harm to juvenile migrating (smolts) CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead for up to 15 years after any construction activities associated with the West Sacramento Project due to impacts to riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is greatest in year 7 for each species at -774 WRI, -774, and -777, respectively, and is reduced to -335, -335, and -441, respectively, by year 15. Between years 15 and 25, the SAM modeled habitat conditions exceed baseline conditions and harm from habitat modification is not expected.

3. Take in the form of harm to juvenile migrating green sturgeon for at least 50 years after any construction activities associated with the West Sacramento Project due to impacts associated with changes in back substrate size and loss of benthic habitat. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm reaches -650 WRI at year 50 and does not recover over the life of the project.

At winter water surface elevations:

1. Take in the form of harm to fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead for up to 1 year after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The amount and extent

of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is greatest in year 0 for each species at -183 WRI, -183, and -349, respectively, and is reduced to -2 for CCV steelhead by year 2. Following year 1 (and year 2 for CCV steelhead), the SAM modeled habitat conditions exceed baseline conditions and harm from habitat modification is not expected.

2. Take in the form of harm to juvenile migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is greatest in year 0 for each species at -2,392 WRI, -2,392, and -1,972, respectively, and is reduced to -272, -272, and -282, respectively, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions and harm from habitat modification is not expected.

3. Take in the form of harm to adult residence CCV steelhead for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is greatest in year 0 at -1,235 WRI, and is reduced to -93, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions and harm from habitat modification is not expected.

4. Take in the form of harm to fry and juvenile rearing sDPS green sturgeon for at least 50 years after project construction due to impacts to riparian habitat, and bank substrate size and loss of benthic habitat. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is -2,264 WRI at year 0 and does not recover over the life of the project. The SAM value is -317 at year 50.

At spring water surface elevations:

1. Take in the form of harm to fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead for up to 1 year after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is greatest in year 0 for each species at -316 WRI, -316, and -550, respectively, and is reduced to -57, -57, and -213, respectively, by year 1. Following year 1, the SAM modeled habitat conditions exceed baseline conditions and harm from habitat modification is not expected.

2. Take in the form of harm to fry and juvenile migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is greatest in year 0

for each species at -2,639 WRI, -2,639, and -2,206, respectively, and is reduced to -312, -312, and -455, respectively, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions and harm from habitat modification is not expected.

3. Take in the form of harm to adult residence CCV steelhead for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is greatest in year 0 at -1,464 WRI, and is reduced to -377, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions and harm from habitat modification is not expected.

4. Take in the form of harm to fry and juvenile rearing sDPS green sturgeon for at least 50 years after project construction due to impacts to riparian habitat, bank substrate size and loss of benthic habitat. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is -2,264 WRI at year 0 and does not recover over the life of the project. The SAM value is -317 at year 50.

5. Take in the form of harm to juvenile migrating sDPS green sturgeon for at least 50 years after project construction due to impacts to riparian habitat, bank substrate size and loss of benthic habitat. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is -650 WRI at year 50 and does not recover over the life of the project.

At summer water surface elevations:

1. Take in the form of harm to fry and juvenile rearing sDPS green sturgeon for at 3 years after project construction due to impacts to riparian habitat, bank substrate size and loss of benthic habitat. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm reaches -1,544 WRI at year 0 and recovers by year 3.

2. Take in the form of harm to juvenile migrating sDPS green sturgeon for at least 50 years after project construction due to impacts to riparian habitat, bank substrate size and loss of benthic. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is -650 WRI at year 50 and does not recover over the life of the project.

Incidental Take Associated with Project Features along the Sacramento Deep Water Ship Channel

1. Take in the form of harm related to reduced survival of adult migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead for at least 50 years after project construction due to impacts to riparian habitat, IWM, and bank substrate

size. The adverse effect is greatest at year 50 at -316 WRI during fall, -124 during winter, -272 during spring, and -316 during summer. The adverse response for green sturgeon is likely twice these values.

2. Take in the form of harm related to reduced survival of fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead for at least 50 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The adverse effect is greatest at year 50 at -157 WRI during fall, -202 during winter, -299 during spring, and -157 during summer. The adverse response for green sturgeon is likely twice these values.

3. Take in the form of harm related to reduced survival of juvenile migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead for at least 50 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The adverse effect is greatest at year 50 at -744 WRI during fall, -1,506 during winter, -1,709 during spring, and -744 during summer. The adverse response for green sturgeon is likely twice these values.

2.8.2 Effect of the Take

In the BO, NMFS determined that the amount or extent of anticipated take is not likely to result in jeopardy to the Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and sDPS green sturgeon or destruction or adverse modification of their critical habitat.

2.8.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

1. Measures shall be taken to ensure that future flood risk reduction projects related to the West Sacramento GRS minimize, to the maximum extent practicable, any adverse effects on federally listed salmon, steelhead and green sturgeon that are subject to this consultation.

2. Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures through the HMMP to ensure their effectiveness.

3. Measures shall be taken to minimize the impacts of bank protection and setback levee construction by implementing integrated conservation measures that provide beneficial growth and survival conditions for salmonids, and the sDPS of North American green sturgeon.

4. Measures shall be taken to insure that contractors, construction workers, and all other parties involved with these projects implement the projects as proposed in the biological assessment and this BO.

5. Measures shall be taken to ensure that riparian habitat within the study area is preserved and protected to the maximum extent feasible for protection of fish habitat features that are the subject of this BO.

2.8.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the Corps or any applicant must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). The Corps or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1: *Measures shall be taken to ensure that future flood risk reduction projects related to the West Sacramento GRS minimize, to the maximum extent practicable, any adverse effects on federally listed salmon, steelhead and green sturgeon that are subject to this consultation.*"

   a. The Corps shall participate in an existing IWG or work with other agencies to participate in a new BPWG to coordinate stakeholder input into future flood risk reduction actions associated with the West Sacramento River GRS. The BPWG will hold technical deliberations over proposed bank protection, including the need (basis of/for design), purpose and proposed designs (emphasis on avoidance and fish-friendly designs). Membership in the BPWG will be subject to agency decisions to participate, but should at a minimum include participation from resource agency staff (USFWS, NMFS, CDFW), DWR and WSAFCA (local sponsors).
   b. The Corps shall coordinate with NMFS during PED as future flood risk reduction actions are designed to ensure conservation measures are incorporated to the extent practicable and feasible and projects are designed to maximize ecological benefits.
   c. For the Deep Water Ship Channel, the Corps shall avoid removing riparian vegetation to the maximum extent practicable, and, where feasible, shall shift levee alignments landward and away from the water.
   d. The Corps shall include as part of the HMMP, and in consultation with NMFS, a Riparian Corridor Improvement Plan with the overall goal of compensating for the impacts to the ecological function and value of the existing levee system within the GRS study area.

2. The following terms and conditions implement reasonable and prudent measure 2: "*Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures through the HMMP to ensure their effectiveness*."

   a. The Corps shall develop a HMMP with an overall goal of ensuring the conservation measures achieve a high level of ecological function and value. The HMMP shall include specific goals and objectives and a clear strategy for maintaining all of the project conservation elements for the life of the project. The HMMP shall be consulted on with NMFS prior to the onset of any riverside construction, including the placement of in-water revetment or removal or riparian vegetation.

b. The HMMP measures shall be monitored by the Corps for 10 years following construction and shall update their O&M manual to ensure the HMMP is adopted by the local sponsor to ensure the goals and objectives of the conservation measures are met for the life of the project.
c. The HMMP shall include specific goals and objectives and a clear strategy for achieving full compensation for all project-related impacts on the affected species described above.
d. The HMMP shall include a compensatory mitigation accounting plan to ensure the tracking of compensatory measures associated with future West Sacramento GRS projects as described in the proposed action.
e. The Corps shall continue to coordinate with NMFS during all phases of construction, implementation, and monitoring by hosting annual meetings and issuing annual reports throughout the construction period as described in the HMMP.
f. The Corps shall host an annual meeting and issue annual reports for five years following completion of project construction. The purpose is to ensure that conservation features of the project are developing consistent with the MMP.
g. The Corps shall update their O&M Manual to ensure that the self-mitigating elements of the HMMP with the goal of meeting SAM values.

3. The following terms and conditions implement reasonable and prudent measure 3: "*Measures shall be taken to minimize the impacts of bank protection and setback levee construction by implementing integrated onsite and offsite conservation measures that provide beneficial growth and survival conditions for salmonids, and the sDPS of North American green sturgeon*."

    a. The Corps shall ensure that, for salmon and steelhead, the maximum SAM WRI deficits for each seasonal water surface elevation as determined appropriate with input from the IWG or the BPWG are fully offset in either the Southport offset area through habitat improvements along the future West Sacramento GRS project or through the purchase of credits at a NMFS approved conservation bank (as described in the BA).
    b. The Corps shall minimize the removal of existing riparian vegetation and IWM to the maximum extent practicable, and where appropriate, removed IWM will be anchored back into place or if not feasible, new IWM will be anchored in place.
    c. The Corps shall ensure that the planting of native vegetation will occur as described in the Corps 2014 BA and within this BO. All plantings must be provided with the appropriate amount of water to ensure successful establishment.

4. The following terms and conditions implement reasonable and prudent measure 4: "*Measures shall be taken to insure that contractors, construction workers, and all other parties involved with these projects implement the projects as proposed in the biological assessment and this BO*."

a. The Corps shall provide a copy of this BO, or similar documentation, to the prime contractor, making the prime contractor responsible for implementing all requirements and obligations included in these documents and to educate and inform all other contractors involved in the project as to the requirements of this BO. A notification that contractors have been supplied with this information will be provided to the reporting address below.
b. A NMFS-approved Worker Environmental Awareness Training Program for construction personnel shall be conducted by the NMFS-approved biologist for all construction workers prior to the commencement of construction activities. The program shall provide workers with information on their responsibilities with regard to Federally-listed fish, their critical habitat, an overview of the life-history of all the species, information on take prohibitions, protections afforded these animals under the ESA, and an explanation of the relevant terms and conditions of this BO. Written documentation of the training must be submitted to NMFS within 30 days of the completion of training.
c. The Corps shall consider installing IWM along future flood risk reduction projects associated with the West Sacramento GRS at 40 to 80 percent shoreline coverage at all seasonal water surface elevations in coordination with the IWG or the BPWG. The purpose is to maximize the refugia and rearing habitats for juvenile fish.

5. The following terms and conditions implement reasonable and prudent measure 5: "*Measures shall be taken to ensure that riparian habitat within the study area is preserved and protected to the maximum extent feasible for protection of fish habitat features that are the subject of this BO*."

    a. The Corps shall develop a Vegetation Variance in consultation with NMFS that protects all vegetation, in place, and allows planting low-risk vegetation on the lower 1/3 slope of the levee system.
    b. The Corps shall develop a Vegetation Variance for all elements of West Sacramento River GRS that are adjacent to habitat that is occupied by federally listed salmon, steelhead and green sturgeon, including the main channel of the Sacramento River (as proposed), the DWSC/Port area, and the Yolo Bypass.

2.9 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

1. The Corps should integrate the 2017 California Central Valley Flood Protection Plan's Conservation Strategy into all flood risk reduction projects they authorize, fund, or carry out.

2. The Corps should prioritize and continue to support flood management actions that set levees back from rivers and in places where this is not technically feasible, repair in place actions should pursue land-side levee repairs instead of waterside repairs.
3. The Corps should consult with NMFS in the review of ETL variances for future projects that require ETL compliance.
4. The Corps should develop ETL vegetation variances for all flood management actions that are adjacent to any anadromous fish habitat.
5. The Corps should use all of their authorities, to the maximum extent feasible to implement high priority actions in the NMFS Central Valley Salmon and Steelhead Recovery Plan. High priority actions related to flood management include setting levees back from river banks, increasing the amount and extent of riparian vegetation along reaches of the Sacramento River Flood Control Project.
6. The Corps should encourage cost share sponsors and applicants to develop floodplain and riparian corridor enhancement plans as part of their projects.
7. The Corps should seek out opportunities for setback levee and other flood management activities that promote overall riverine system restoration.
8. The Corps should support and promote aquatic and riparian habitat restoration within the Sacramento River and other watersheds, especially those with listed aquatic species. Practices that avoid or minimize negative impacts to listed species should be encouraged.
9. The Corps should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid habitat restoration projects.
10. The Corps should continue to work with NMFS and other agencies and interests to restore fish passage to support the improved growth, survival and recovery of native fish species in the Yolo Bypass and other bypasses within the Sacramento River Flood Control Project.
11. The Corps should coordinate with the IEP to further evaluate the ecosystem function of the SDWSC/Port and consider developing a study to re-operate the Jefferson Ship Locks to enhance fish passage for salmon, steelhead and sturgeon and estuarine habitat values.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

2.10 Reinitiation of Consultation

This concludes formal consultation for the West Sacramento River GRS. As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) the amount or extent of incidental taking specified in the incidental take statement is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the Corps and descriptions of EFH for Pacific coast salmon (PFMC 1999) contained in the fishery management plans developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce.

The proposed action is described in detail in Section 1.3 of the West Sacramento River GRS BO.

3.1 Essential Fish Habitat Affected by the Project

The action area for the EIP has been identified as EFH for Pacific coast salmon. Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), CV spring-run Chinook salmon (*O. tshawytscha*), and CV fall-/late fall-run Chinook salmon (*O. tshawytscha*) are species managed under the Pacific coast salmon fishery management plan that occur within the proposed action area.

This BO addresses Sacramento River winter-run and CV spring-run Chinook salmon (*O. tshawytscha*). The Sacramento River winter-run and CV spring-run Chinook salmon are listed under both ESA and the MSA and potentially will be affected by the Southport EIP. This EFH consultation will concentrate on CV fall-/late fall-run Chinook salmon (*O. tshawytscha*) because their habitat is covered under the MSA but not covered in subject BO.

The Habitat Areas of Particular Concern (HAPCs) in the action area include complex channels, floodplain habitats and constrained channels with large woody debris.

3.2 Adverse Effects on Essential Fish Habitat

The effects of the proposed action on Pacific Coast salmon EFH will be similar to those discussed in the *Effects of the Action* section (2.4) for Sacramento River winter-run and CV spring-run Chinook salmon. Based on the information provided, NMFS concludes that the proposed action would adversely affect EFH for federally managed Pacific salmon. A summary of the effects of the proposed action on EFH for Chinook salmon are discussed below.

Adverse effects to the HAPCs of Pacific salmon EFH resulting from the proposed action construction activities may contribute sediment, increase turbidity, and increase localized sound levels, including areas downstream and upstream of the construction site. These impacts will occur only during the time when construction is occurring in or adjacent to the water column. There is potential for toxic compounds to be introduced into EFH during construction. This could occur at any time during the construction, both during in-water and out-of-water phases. All of the above impacts will be short-term. Construction activities may also eliminate or alter habitat that is essential to the life-cycle of Pacific salmon. For example, the addition of rock revetment to a previously vegetated bank may eliminate juvenile rearing habitat. These habitat impacts are better illustrated in Table 12 of this EFH consultation and Table 43 of the Corps BA that summarizes SAM deficits for the West Sacramento River GRS.

For example, some SAM WRI values typically show small deficits that recover, for example fry and juvenile rearing in the fall. Conversely, some SAM values show long-term benefits (no deficits) such as fall-run Chinook salmon adult migration in the fall.

Table 12: West Sacramento Project Maximum SAM Deficits and Duration of Deficits by Species, Life-Stage, and Season

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)
Fall-run Chinook Salmon			
Fall	Adult Migration	No deficit	NA
	Fry and Juvenile Rearing	-85	10
	Juvenile Migration	NA	NA
Winter	Adult Migration	-455	3
	Fry and Juvenile Rearing	-183	3
	Juvenile Migration	-2,392	2
Spring	Adult Migration	NA	NA
	Fry and Juvenile Rearing	-316	3
	Juvenile Migration	No data	No data
Late Fall-run Chinook Salmon			
Fall	Adult Migration	No deficit	NA
	Fry and Juvenile Rearing	-85	10
	Juvenile Migration	-774	15
Winter	Adult Migration	-627	3
	Fry and Juvenile Rearing	-183	2
	Juvenile Migration	-2,392	3
Spring	Adult Migration	-773	4
	Fry and Juvenile Rearing	-316	2
	Juvenile Migration	No data	No data

3.3 Essential Fish Habitat Conservation Recommendations

Fully implementing these EFH conservation recommendations will protect, by avoiding or minimizing the adverse short-term habitat effects described in section 3.2. The Corps should mitigate for WRI deficits by offsetting the maximum deficits. Below is a summary of WRI that should be mitigated to minimize the adverse effects of the Southport EIP to Pacific coast salmon species. The Corps and WSAFCA should offset deficits either onsite or at a NMFS approved conservation bank. The mitigation should be at a 1:1 ratio if conducted prior to the compensation timing schedule described in the *Analytical Approach* section of the BO, or at a 3:1 ratio if carried out any later.

1. The maximum impact from the West Sacramento Project to adult fall-run Chinook salmon habitat is -455 WRI for 3 years.

2. The maximum impact from the West Sacramento Project to juvenile fall-run Chinook salmon habitat is -2,392 WRI for 2 years.

3. The maximum impact from the West Sacramento Project to adult late-fall run Chinook salmon habitat is -773 WRI for 4 years.

4. The maximum impact from the West Sacramento Project to juvenile late-fall run Chinook salmon habitat is -2,392 WRI for 3 years.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Corps must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, compensate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The Corps must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the Corps. Other interested users could include WSAFCA, USFWS, CDFW, or DWR. Individual copies of this opinion were provided to the Corps and WSAFCA. This opinion will be posted on the Public Consultation Tracking System web site (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and the EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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